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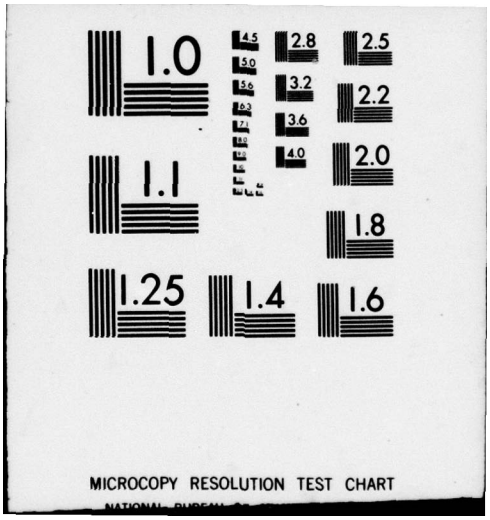
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RADC-TR-79-32
Final Technical Report
March 1979

RECONNAISSANCE SENSOR SYSTEM EXPLOITATION

Rome Research Corporation

Richard R. Petroski

ROME AIR DEVELOPMENT CENTER
Air Force Systems Command
Griffiss Air Force Base, New York 13441

This report has been reviewed by the RADC Information Office (OI) and is releasable to the National Technical Information Service (NTIS). At NTIS it will be releasable to the general public, including foreign nations.

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Project Engineer

APPROVED: Howard Davis

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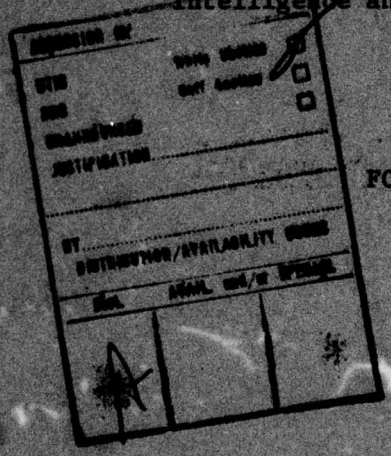

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20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

Documented in this report are the primary tasks accomplished under the project titled, "Reconnaissance Sensor System Exploitation". It is intended to present a brief summary of the sensor evaluations and exploitation of reconnaissance equipment and techniques performed under the program. Support provided in the RADC/IRR Reconnaissance Data Base along with the support provided by the Northeast Test Area (NETA) is also included. A brief description of the programs that were supported at the Military Equipment Display and Engineering (Cont'd)

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Area (Stockbridge Test Annex) offer the reader a summary of the equipment and support available to reconnaissance sensor test programs. Other efforts accomplished ~~throughout~~ the tenure of the program, considered to be of limited interest to the reconnaissance community, are not included in this report. Detailed information on any of the efforts completed during the contract may be obtained from RADC/IRRE, Griffiss AFB NY 13441.

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This effort contributed significantly toward accomplishing the goals of technical program objective (TPO) R2C. The sensor systems analyzed during the duration of the contract covered the full spectrum of sensors currently available. Further, the work extended the base of knowledge associated with both the sensors themselves and interpretation techniques used to exploit the imagery. This type of knowledge and understanding is essential in the development of fieldable exploitation systems for both the Tactical Air Forces and the Strategic Air Command.

Stephen J. Anthony

STEPHEN J. ANTHONY, 1LT, USAF
Project Engineer

SECTION 1

INTRODUCTION

This report documents the activities performed under Contract F30602-76-C-0431; it covers the period 1 September 1976 through 31 October 1978. A number of USAF and other DOD programs were supported during this time frame and are discussed under the following four major tasks:

1.1. SENSOR EVALUATIONS

The primary objective of this task was to determine the reconnaissance effectiveness of various airborne sensor systems and to identify their performance characteristics and peculiarities. The use of different film and filter combinations to achieve optimum results was investigated. In addition, aerial imagery was analyzed to evaluate the effectiveness of various digital processing techniques. The results of image recording and processing from proto-type and new recording and processing systems were also investigated.

Appraisal of system performance by skilled, experienced image interpreters remains the least controversial and most effective means of evaluating sensor modifications and new applications.

1.2. DATA BASE OPERATIONS

The RADC/IRR Reconnaissance Data Base has been a valuable resource for multisensor aerial imagery; ground truth data, technical reports, and other intelligence information to be drawn upon by members of the military and industrial reconnaissance communities. Since its inception in 1965, the Data Base has been continually updated to stay current with the changing trends and programs. It is unique in that it provides a readily available source of information to aid in the solution of reconnaissance problems concerning:

- Multisensor Interpretation and Analysis Techniques,
- Sensor System Development,
- Interpretation Equipment Development,
- Target Location, Detection and Identification,
- Digital Image Processing Techniques, and
- Image Recording, Processing and Reproduction Development.

Throughout the tenure of this contract, the Data Base has been in operation eight hours a day, Monday through Friday.

1.3. FLIGHT PLANNING

Effective flight planning was performed as required throughout the duration of the contract. Reconnaissance mission planning consisted of determining appropriate flight parameters to assure optimum results. In addition, determination of the number of flight lines required, and the amount of film necessary to complete each data collection mission was accomplished. Recommendations for appropriate camera settings were provided to equipment operators, and the aircrews were briefed prior to each mission flown during the twenty-five months of this contract.

1.4. NORTHEAST TEST AREA (NETA SUPPORT)

The Northeast Test Area comprises two elements:

(1) Simulated NATO Tactical Targets, and

(2) Military Equipment Display and Engineering Area.

The Northeast Test Area (NETA), developed under contract for the Image Systems Branch (IRR) of the Rome Air Development Center, satisfied the existing need for a temperate zone test area.

Three flight corridors and a designated boundary encompassing the Albany, N.Y. area contain seventy-two NATO target analogs. Throughout the contract duration, target folders of these targets have been updated with current imagery examples (as they become available), and various types of ground truth data.

The Military Equipment Display and Engineering Area complements the simulated NATO Tactical Targets. Using the Stockbridge Test Annex to provide a tactical setting, realistic military target groups have been positioned throughout the site. Target groups include:

SAM SITE

AAA SITE

SSM SITE

HEAVY FIELD ARTILLERY BATTERY

MORTAR BATTERY

ARMORED GROUP (To include a dummy tank)

ASSAULT ENGINEER GROUP

MILITARY VEHICLE CONVOY

TACTICAL SUPPLY POINT

TACTICAL COMMAND POST HEADQUARTERS

In addition, a variety of radar resolution arrays are available and are surveyed into position for side-looking-airborne radar (SLR) tests.

Throughout the contract, the site was configured to support a number of flight test programs, maintenance of all equipment, and ground truth documentation of the site was accomplished. Assistance was also provided in the preparation of sensor test plans.

This report contains a description of the work performed under these tasks during the twenty-five months of the contractual effort.

SECTION 2

PROGRAM TASKS

2.1. TASK I - SENSOR EVALUATIONS

The evaluations accomplished during the period of this program varied in their objective and scope. Determination of the reconnaissance effectiveness and performance capabilities of each sensor system evaluated was provided to the RADC Program Engineer upon completion of each sensor test.

An initial step in performing sensor evaluation exercises involved a clear and complete definition of objectives to be addressed, since they represent the most important criterion against which subsequent decisions and trade-offs must be made. Objectives that were addressed included all or part of the following:

(1) Overall quality of sensor data,

(2) Image resolution and repeatability,

(3) Image characteristics,

(4) Effective altitude envelope,

(5) Analysis of target detection and identification, and

(6) Potential of the sensor system.

By satisfying these objectives, the necessary data has been gathered to:

(1) Provide recommendations for use in the development of more advanced sensor systems, recording equipment, and processing equipment,

(2) Develop, where practical, new or improved interpretation techniques, and

(3) Provide recommendations for the implementation of the techniques on more advanced processing and exploitation systems.

Brief summaries of each evaluation are presented to document the objective, evaluation methodology, and results. Detailed information on each evaluation can be obtained by contacting RADC/IRRE, Griffiss AFB, N.Y. 13441.

2.1.1. Physical Parameters/Image Characteristics

Sensor data quality of all imagery received in the Data Base was assessed in terms of certain image characteristics, such as contrast, tonal range, geometric fidelity and resolution. These measurements were extracted from film or from digital representations of film data. Image quality of forward-looking infrared (FLIR) video data was also evaluated to determine the reconnaissance effectiveness of FLIR imagery.

o Image Contrast and Tonal Range - whenever required, these values were determined by measuring on test film calibrated against a standard grey wedge. Consistency of contrast and tonal range over the width of all imagery evaluated was determined by members of the project team.

o Geometric Fidelity - as applied to optical systems represents a measure of the dimension and shape reproduction accuracy of the sensor systems. Determination of distortion caused by numerous conditions such as camera vibration, lens aberration, image motion compensation (IMC) error and others was recorded on all imagery evaluated. Line scan systems have many factors which can influence geometric fidelity (and resolution) such as detector alignment, mirror jitter, scan start/stop time, and sample time. Where information was available on the ground position and dimensions of certain identifiable targets within an image scene, calculations were made to determine errors in positional accuracy and target measurements. The degree of mensuration precision required was specified in the test plan directives associated with the sensor evaluation.

o Resolution Measurements - when specified in test plan directives, image resolution in both Line of Flight (LOF) and Cross Line of Flight (XLOF) was measured. To measure photographic resolution, the following formula taken from the 1977 edition of

McDonnell Douglas Corporation Reconnaissance Handy Book For The Tactical Reconnaissance Specialist was used:

$$R = \frac{(0.0396)\ \ (h)}{(x)\ \ \ \ (f)}$$

where:

R = Photo resolution (lines/mm)

h = Height (AGL feet)

f = Focal length of camera (inches)

x = Combined width of bar and space taken from the smallest ground resolution target resolved (feet).

Ground resolution was usually of primary concern during photographic evaluation. Ground resolution depends upon film resolution, lens resolution and imagery scale. To measure ground resolution, the following formula also taken from the 1977 edition of the McDonnell Douglas Corporation "Handy Book" was used:

$$G = \frac{h}{(f)\ \ (R_{LF})\ \ (25.4)}$$

where:

G = Ground resolution (feet)

h = Height (AGL feet)

f = Focal length of camera (inches)

R_{LF} = Lens/film resolution (lines/mm)

Since most photography received for evaluation was not flown over a Standard Military Bar Target, the primary means used to determine the approximate resolution of collected imagery was to perform ground resolution measurements.

Measurement of radar resolution was accomplished by analyzing Synthetic Aperature Radar (SAR) imagery of radar corner reflector arrays arranged in a configuration designed to allow the image interpreter to determine if target separation exists, and thus assign a resolution value both in azimuth and range.

2.1.2. Evaluation of Conventional Aerial Photography

All conventional aerial photographic missions were evaluated to determine:

- Overall image quality,
- If any camera malfunction occurred,
- If there was adequate overlap between frames (where applicable),
- If the target area was adequately imaged,
- If any film processing problems occurred, and
- If the mission objectives were met.

Evaluation of the performance of the camera as a function of altitude and/or scale was one of the objectives typically encountered. A "Mission Summary" Form (Figure 2-1) was completed for each mission evaluated and included as part of a mission data packet.

Camera malfunctions occurred on less than 2% of all photographic missions evaluated, while film processing problems were apparent on less than 1% of collected imagery. Image degradation for the most part was the result of improper exposure settings and/or camera speed.

In addition, adequate overlap between frames (60%) was not realized on all missions due to improper intervalometer settings or incorrect aircraft velocity.

Table 2-1 lists the number of photographic missions by camera type evaluated during the twenty-five months of the contractual effort. Overall image quality is also included.

SUMMARY OF PHOTOGRAPHIC MISSIONS

CAMERA	NUMBER OF MISSIONS EVALUATED	OVERALL IMAGE QUALITY
RC-8	11	Fair - Excellent
KC-1B	14	Fair - Excellent
KA-76	2	Fair - Good
KS-87/87B	10	Fair - Good
KA-91	1	Good
KA-56 LPAN/HPAN	7	Fair - Good
KA-62 Vertical & Oblique	1	Fair - Good
TOTAL	46	

TABLE 2-1

MISSION SUMMARY

MISSION OBJECTIVE(S):

PROJECT ENGINEER:

SENSOR OPERATOR:

MISSION DATA

PROJECT:

MISSION #:

A/C TYPE/TAIL #:

ALTITUDE(S):

WEATHER CONDITIONS:

DATE FLOWN:

SENSOR:

FILM TYPE:

SCALE(S):

DATA COLLECTION TIME:

EVALUATION

	YES	NO	%
OBJECTIVES COVERED:	☐	☐	____

OVERALL IMAGE QUALITY:

FILM FOOTAGE EXPENDED:

OVERLAP: ____%

SIDELAP: ____%

REMARKS:

Figure 2-1. Mission Summary Form

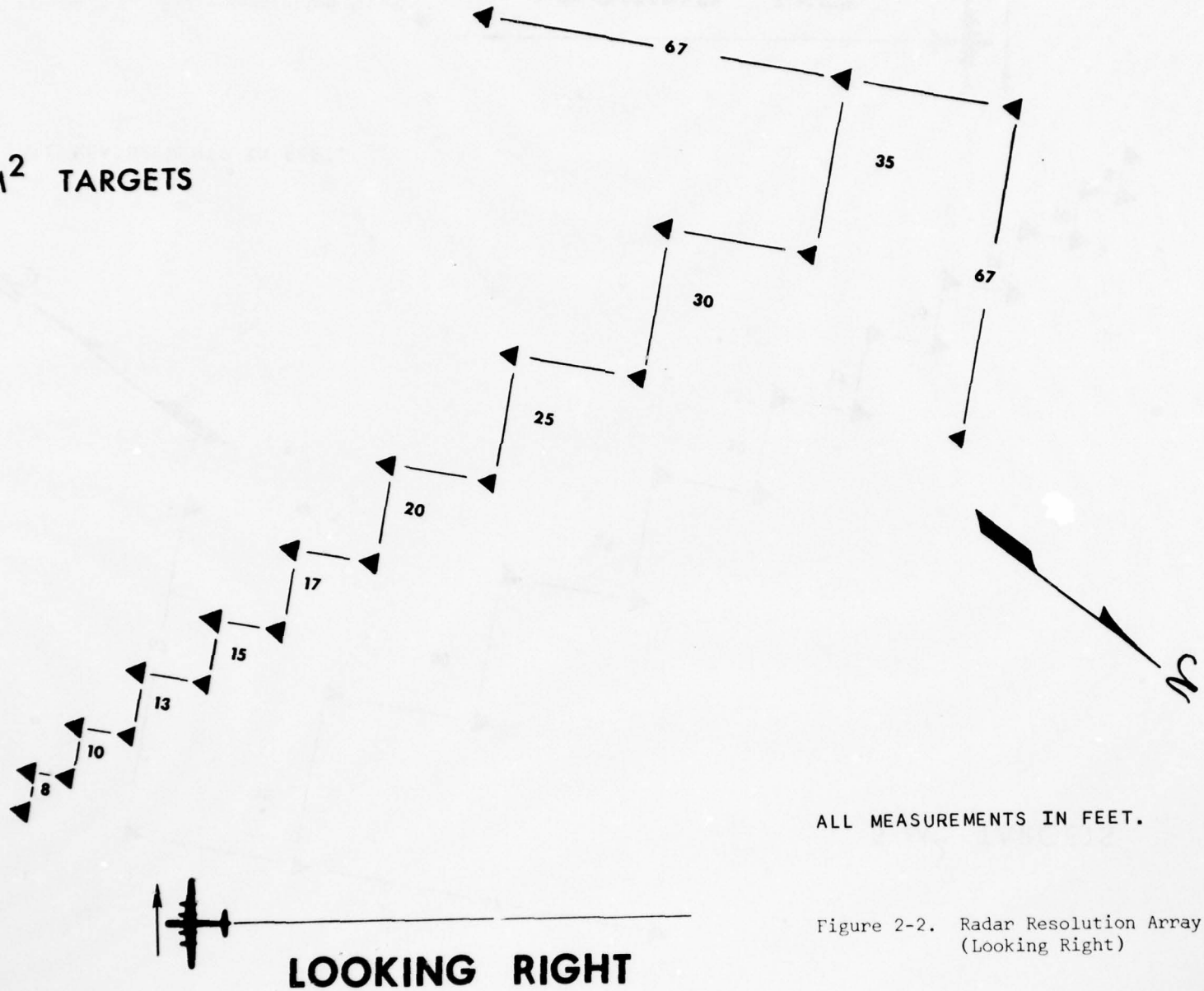
2.1.3. "PEACE ECHO VII", APD-10 SLR Evaluation

The objective of this evaluation was to analyze APD-10 SLR imagery collected in two extended stand-off modes (7 and 8). Imagery from eighteen different missions (ground data and airborne) was evaluated for overall image quality and to determine if the operating parameters of the sensor system were within specifications. Each image mode was examined to evaluate the target signal strength, dynamic range, quality of ground paint, channel to channel balance, noise level and correlator focus. Imaging peculiarities such as stars/spikes, target swallow, and target saturation and blooming were recorded. Resolution was measured on 223 passes, each pass covering two resolution arrays. (See Figures 2-2 and 2-3). (All information was recorded on forms similar to the ones depicted in Figures 2-4 and 2-5).

This evaluation was conducted at Goodyear Aerospace Corporation, Litchfield Park, Arizona.

2.1.4. "REFORGER 76"/"REFORGER 77" Imagery Evaluations

Forty-three APD-10 SLR missions and seven AN/AAD-5 IR missions collected during the REFORGER 76 and REFORGER 77 exercise were analyzed and evaluated prior to their incorporation into the RADC/IRR Reconnaissance Data Base. The overall image quality was



ALL MEASUREMENTS IN FEET.

Figure 2-2. Radar Resolution Array (Looking Right)

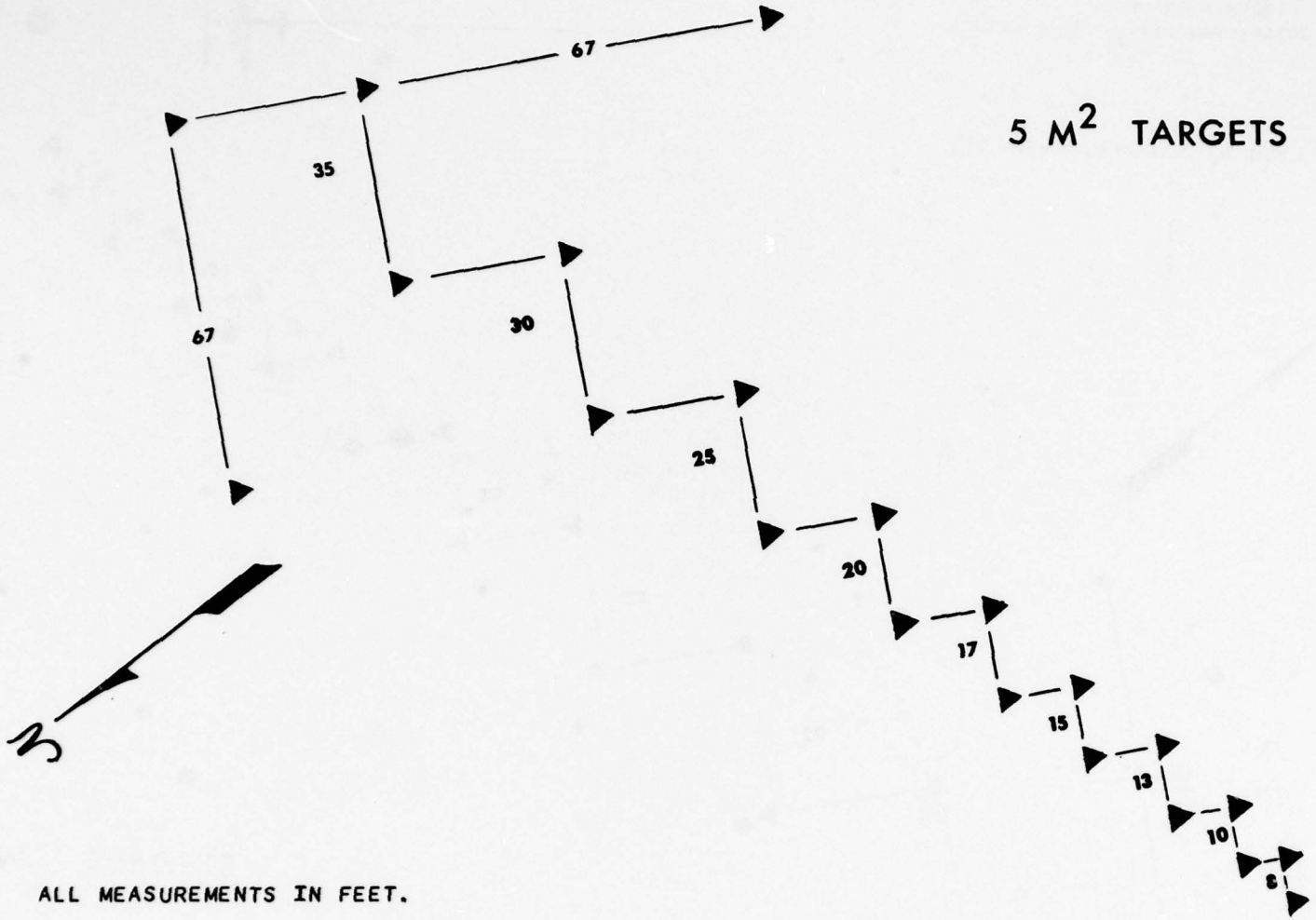


Figure 2-3. Radar Resolution Array (Looking Left)

SAR IMAGERY EVALUATION

SYSTEM _____ FLIGHT NUMBER _____ FLIGHT DATE _____ AIRCRAFT NUMBER _____

PARAMETERS	PASS ___ MODE ___				PASS ___ MODE ___				PASS ___ MODE ___			
	A	B	C	D	A	B	C	D	A	B	C	D
RESOLUTION - RANGE X AZIMUTH (Normalized to Spec'd Value)	X	X	X	X	X	X	X	X	X	X	X	X
STRONG TARGET/SIGNAL STRENGTH												
Stars/Spikes												
Saturation/Blooming												
Target Swallow												
Weak												
GROUND PAINT												
Good												
Poor												
Light }												
Moderate } Noise												
Heavy }												
DYNAMIC RANGE Good												
Poor												
Streaks Along Track												
Banding Cross Track												
Correlator Focus												
CHANNEL TO CHANNEL BALANCE												
ADAS												
COMMENTS/OTHER EFFECTS												

Figure 2-4. SAR Imagery Evaluation Form

Flight No._____ Correlation _____ Passes_____

Flight Date_____ Correlation _____ Passes_____

Date_____

Analysts _____

		Array #1			Array #2			Tact		Dyn		
Pass	Mode	Rn	Az	Ch	Rn	Az	Ch	Tgts	Ch	Rng	Ch	Comments

Figure 2-5. Image Analysis Report Form

recorded, and targets were annotated on each mission. Assistance was provided to RADC personnel in selecting specific types of image scenes and targets to support other RADC research and development programs.

2.1.5. Evaluation of Pave Tack FLIR Tapes for Real-time FLIR Image Enhancement

Pave Tack FLIR tapes from seven different missions were evaluated at USAF/TAWC, Eglin AFB, FL. FLIR video from each tape was viewed on a CONRAC RBQ 17C video display monitor. Each video scene was analyzed to determine:

- Scene quality,
- Amount of noise, jitter, etc. apparent on each scene,
- Number and types of targets imaged on each scene, and
- Interpretability of each target recorded.

Missions containing designated types of tactical targets were copied using an IVC 825A recorder. A log was compiled which recorded all targets contained on each mission tape by time-segment. All tapes were properly labeled and classified prior to being shipped to the RADC/IRR Reconnaissance Data Base. This data is currently in the process of being digitized for the RADC Real-time FLIR Image Enhancement Program.

2.1.6. UPD-X Evaluation

Side-looking airborne radar imagery collected during the "Summer Phase" of the "UPD-X Program" was evaluated to determine:

- o Overall image quality,
- o Occurrence of sensor malfunctions, and
- o Percentage of target area imaged.

Imagery from 57 passes optically correlated in the channel "B" mode was analyzed prior to incorporating it into the data base storage and retrieval system.

2.1.7. Image Compression Program

In support of the RADC/IRRP "Image Compression Program", a number of conventional aerial photographic missions were researched and selected for duplication. A large number of imagery examples were required to satisfy this program. Aerial photography was interpreted to provide a wide variety of image scenes depicting different target and target background examples at different scales. Each frame of imagery was "scaled" by Rome Research Corporation interpreters to insure accuracy for the program.

2.1.8. Evaluation of Coded Aerial Images

Aerial photography that was digitized in different "codes" was evaluated and ranked according to overall image quality and ease of interpretability. All images were taken from a T.V. display with 512 x 512 picture elements. This represents much less resolution than the more standard 2048 x 2048, 9" photographs that were coded.

Coding techniques included:

- o Two dimensional cosine transform methods: zonal, adaptive zonal,
- o Four class zonal (Chen & Smith),
- o Threshold,
- o Hybrid - one dimensional cosine with DPCM (Digital Pulse Coded Modulation), and
- o Two spatial techniques - MAPS (CDC) and Block Truncation (Purdue).

Original photographs were used as a basis for comparing the errors caused by the various coding techniques.

Twelve sets of 5-7 images each were evaluated by five Rome Research Corporation image interpreters. Evaluation results were recorded on forms included as Figures 2-6 and 2-7.

INTERPRETER INITIALS R. R. P.

SET NUMBER C1 COMPRESSION 1.5 bits/pixel ERROR PROBABILITY 0

Original Picture 119 is 512 x 512 at 6 bits/pixel

Original Picture using PCM with same error rate -

Photos in set 102, 114, 408, 704, 716, 741, _____

BEST

RANKING

WORST

PIC. NO. 716	COMMENTS: Ex. I favor this frame over the original. Although there is little difference in the overall image quality, I feel that the "tone" of #716 is better.
PIC. NO. 741	COMMENTS: Ex. More background detail (particularly around AAA Site) than on original.
PIC. NO. 704	COMMENTS: ↕
PIC. NO. 102	COMMENTS: ↕
PIC. NO. 408	COMMENTS: ↕
PIC. NO. 114	COMMENTS: ↕ "Block-like" patterns throughout this frame are quite apparent; however, this does not "take away" from the target signatures.
PIC. NO.	COMMENTS:

Suggested abbreviations for comments:

Ex = excellent (no significant difference from original)

↕ = two methods are about the same

✗ = unacceptable (useless)

Figure 2-6. Coded Aerial Imagery Evaluation Form

INTERPRETER INITIALS R. R. P.

SET NUMBER C2 COMPRESSION 1.5 bits/pixel ERROR PROBABILITY 10^{-3}

Original Picture 119 is 512 x 512 at 6 bits/pixel

Original Picture using PCM with same error rate 304

Photos in set 221, 222, 710, 718, 745, 746, _____

BEST

RANKING

WORST

PIC. NO. 710	COMMENTS:	Overall image quality appears to be better than original with the exception of the "blocks" throughout the frame. These blocks would have an effect on target ID if they covered the target.
PIC. NO. 746	COMMENTS:	Same as for #710.
PIC. NO. 745	COMMENTS:	Same as for #710 - "Block" obscures portion of tank located to the right of the frame.
PIC. NO. 718	COMMENTS:	Even with noise introduced, little (if any) target information is lost. There appears to be less target-to-background tone differences.
PIC. NO. 221	COMMENTS:	
PIC. NO. 222	COMMENTS:	"Block-like" patterns are very apparent, it would hinder target identification if they were located in the target area.
PIC. NO.	COMMENTS:	

Suggested abbreviations for comments:

Ex = excellent (no significant difference from original)

↕ = two methods are about the same

✕ = unacceptable (useless)

Figure 2-7. Coded Aerial Imagery Evaluation Form

This evaluation was conducted in support of RADC/DCC.

2.1.9. AN/AAD-5 Fiber Optic Film Recorder (FOFR) Capability

The objective of this test and evaluation was to determine the image recording capabilities of the FOFR by comparing the imagery it had recorded to the imagery recorded by the Laser Beam Recorder (LBR), using identical input. The initial requirement of this task was to assist the RADC Program Engineer in preparing a test plan for the evaluation. (See Appendix A). This was accomplished prior to the evaluation of FOFR produced imagery.

Imagery from three Quick Strike Reconnaissance (QSR) Initial Operational Test and Evaluation (IOT&E) missions were evaluated at USAF/TAWC, Eglin AFB, FL during actual QSR missions. Imagery from three additional missions were evaluated at RADC. The subjective evaluation consisted of a side-by-side comparison of the FOFR and LBR produced imagery. Each image scene was analyzed to determine the recording capability of the FOFR using tactical targets for test data. Interpreter comments were recorded regarding:

- Overall image quality,
- Number of targets detected, and
- Number of targets identified.

During the objective portion of the test, two types of data were generated from within a laboratory situation:

- o Simulated Video, and
- o Receiver Bar Target Video.

The simulated video imagery consisted of a continuous frequency output with variable amplitudes at the following frequencies:

- o 1.2 MHz,
- o .625 MHz,
- o .312 MHz, and
- o .156 MHz.

All imagery generated by the FOFR was evaluated for consistency of contrast over the width of the film.

Receiver bar target video imagery was generated using five target bars ranging in size from 1/4 MIL to 2 MIL. Three different V/h values were employed for each bar target. Generated FOFR imagery was rated in terms of resolution and density, to comparable data generated by the LBR.

Rome Research Corporation image interpreters and trained USAF, QSR image interpreters participated in this evaluation.

2.2. TASK II - DATA BASE OPERATIONS

The objective of this task, as stated in the Research and Technology Work Statement, was to maintain, update, and enhance a reconnaissance multisensor data base for support of research and development programs and to prepare multisensor test photos and other photographic products, to include microfilm data. Ordering and maintenance of maps, charts, and map products were also a part of this task. In addition, security classification and downgrading of data was to be performed in accordance with AFR 205-1 and DOD 5200-1-R.

To accomplish these objectives, Rome Research Corporation's (RRC's) program staff performed three basic functions:

(1) Data collection,

(2) Data reduction, and

(3) Data maintenance.

Tasks within the above categories include acquisition of aerial imagery from various sources, logging, screening, targeting, plotting (to include maintenance and updating of a master cover index of imagery holdings), storing and retrieving of data; filling imagery and ground truth requests; receiving, logging, storing, retrieving and microfilming documents; ordering and maintaining maps and charts; and filling various

work order requests while maintaining security procedures. Figure 2-8 shows the principal data base functions identified above. A description of each major data base task undertaken is outlined in the following sub-paragraphs.

2.2.1. Data Collection and Reduction

2.2.1.1. Imagery Collection and Reduction

Imagery from 237 missions were received and incorporated into the data base storage and retrieval system during the course of the contract. Table 2-2 depicts the types of imagery received, the number of missions by sensor type, and the programs under which the imagery was collected. Figure 2-9 shows the principal functions when reducing multisensor imagery and sensor tape data. Any collateral imagery data such as flight logs, charts and maps, and ground truth information was incorporated into a mission packet with the imagery plot and stored in the data base.

2.2.1.2. Document Collection and Reduction

Currently there are over 4,100 technical documents and reports held in the data base pertaining to reconnaissance, remote sensing and intelligence. A total of 160 documents were received in the data base during the twenty-five months of the contract.

DOCUMENTS	GROUND TRUTH MATERIALS	MAPS & CHARTS	IMAGERY	MAGNETIC/ DIGITAL TAPE	SECURITY
REVIEW	DEVELOP	ORDER	LOG	LOG	RECEIPT PREPARED
CATALOG	PREPARE	STORE	TITLE	TITLE	ACCOUNT
MICROFILM	REPRODUCE	RETRIEVE	ANNOTATE	STORE	CONTROL
STORE	VIEWGRAPH PREPARATION	UPDATE HOLDINGS	REPRODUCE	RETRIEVE	DOWNGRADE
RETRIEVE	MICROFILM	MICROFILM	PLOT		REPRODUCE
	CATALOG		EVALUATE		MAIL
	STORE		ANALYZE		
	RETRIEVE		PREPARE MSN SUMMARY		DOD 5200.1-R
			PLOT TRANSFER TO MASTER COVER INDEX		AFR 205-1
			MASTER COVER TRACE (MCT) MICROFILMED		DOD 5220.22-M
			MCT ASSEMBLED INTO MICROFICHE JACKETS		DOD 5220.22-R
			VIEWGRAPH PREPARATION		
			ASSEMBLE PLOT PACKET		
			STORE		
			RETRIEVE		

Figure 2-8. Principal Data Base Functions

IMAGERY RECEIVED IN THE DATA BASE

NUMBER OF MISSIONS RECEIVED	SENSOR(S)/IMAGE TYPE	PROGRAM
31	AN/AAD-5 Infrared (IR)	TAWC Tests
10	KS-87/87B Photo	TAWC Tests
7	KA-56 HPAN/LPAN	TAWC Tests
1	KA-91 Photo	TAWC Tests
35	AN/AAD-5 IR	Brave Shield/ Quick Strike Reconnaissance (QSR) Orientation Training
54	Pave Tack FLIR	QSR
7	Pave Tack FLIR	Real-Time FLIR Image Enhancement
14	KC-1B Photo	*6244 Flight Test
9	RC-8 Photo	*6244 Flight Test
2	KA-76 Photo	U.S. Army Reserve
1	APD-10 (SLR) Side-Looking-Airborne Radar	Random Radar Data Base (Europe)
2	APD-10 SLR	REFORGER 76
7	AN/AAD-5 IR	REFORGER 76
1	APS (Control Point Data)	REFORGER 76
41	APD-10 SLR	REFORGER 77
3	IRIS Photo (Continued)	REFORGER 77

Table 2-2

IMAGERY RECEIVED IN THE DATA BASE
(Continued)

NUMBER OF MISSIONS RECEIVED	SENSOR(S)/IMAGE TYPE	PROGRAM
3	UPD-X SLR (Channel "B" only)	UPD-X Summer Tests
7	AN/AAD-5 IR	FOFR Fiber Optics Film Recorder Feasibility Tests
1	"HOT MOCK-UP" Tests (FOFR)	FOFR Fiber Optics Film Recorder Feasibility Tests
1	"HOT MOCK-UP" Tests Laser Beam Recorder (LBR)	FOFR Fiber Optics Film Recorder Feasibility Tests

*Camera flown by the 4950th Flight Test Division, WPAFB, Ohio.

Table 2-2

DATA REDUCTION FUNCTIONS

- o Screening
- o Logging
- o Titling
- o Annotating/Targeting
- o Reproducing*
- o Plotting
- o Master Cover Index Preparation
- o Data Packet Preparation
- o Storing
- o Retrieving*

(*As Required)

Figure 2-9

Documents received in the data base were screened to determine if the information they contained was of value to data base users. If the documents were found to be useful, they were logged into the data base storage and retrieval system.

2.2.1.3. Support Data Collection and Reduction

Any collateral imagery data, e.g., intelligence/imagery interpretation reports, ground truth information, flight logs for individual missions, and charts and maps were logged into the data base to correspond with the appropriate roll(s) of imagery. A special area was set aside for storing imagery and ancillary mission data acquired during engineering test flights.

2.2.2. Data Maintenance

2.2.2.1. Updating, Maintenance and Distribution of Maps, Charts and Related Products

The most voluminous category of support data held in the data base is the map and chart file. The primary purpose of these maps and charts is to provide plotting bases for imagery coverage, as well as being used in mission planning.

In addition, they offer users a comprehensive reference of those DMA products which have a broad application to all military type operations.

The data base map and chart holdings cover all of CONUS and sections of foreign countries at various scales including:

- o 1:24,000 USGS 7.5 Min. Series
- o 1:25,000 DMA Series
- o 1:50,000 DMA Series
- o 1:62,500 USGS 15 Min. Series
- o 1:200,000 Air Targeting Charts
- o 1:250,000 Air Targeting Charts (JOGR)
- o 1:250,000 AMS Series (Topographic)
- o 1:250,000 JOG (A&G)
- o 1:500,000 TPC's
- o 1:1,000,000 ONC's
- o 1:2,000,000 JNC

The requisitioning procedures for these products are outlined in DMA catalogs and are submitted on SF 344 Multiuse Standard Requisitioning/Issue System Document (Figure 2-10).

USGS maps and charts were ordered by standard military letter from:

U.S. Geological Survey
1200 South Eads Street
Arlington, Virginia 22202

SAMPLE ORDER

DOCUMENT IDENTIFICATION

1 DOC. IDEN	2 ROUTING IDEN.	3 M&S	DOCUMENT NUMBER 9 10 REQUISITIONER	DOCUMENT NUMBER 11 DATE	13 DEM	14-15F SUPPLEMENTARY ADDRESS	16F SIG	17 FUND	18F DISTRIBUTION	19 PROJECT	20 PRIORITY	21 REQ D DELIVERY DATE	SIGNATURE *(If required)*
1-3	4-6	7	30 35	36 39	44	45-50	51	52-53	54 56	57-59	60-61	62-64	
AOD	HM8	Ø	JM 1490	B Ø16			D				14		

REQUISITION DATA

STOCK NUMBER 4 FSC	STOCK NUMBER 5. FIIN	STOCK NUMBER 6 ADDITIONAL	7 UNIT OF ISSUE	8. QUANTITY	12 SERIAL	14-15V SUPPLEMENTARY ADDRESS	16V SIG	18V DISTRIBUTION	19V PROJECT	22 ADVICE	NOTE: Entries in shaded blocks may be in either the FIXED (F) or VARIABLE (V) sections—NEVER in both.
8 11	12 18	19-22	23-24	25-29	40-43	45-50	51	54-56	57-59	65-66	23. REMARKS
15Ø1R	351939		EA	ØØØØ6	0001					2B	
15Ø1R	342160		EA	ØØØ12	0002						
1501A	NK1812		EA	ØØØØ8	0003						
ONCXX	EØ4		EA	ØØØØ6	0004						
TPCXX	F19D		EA	ØØ16Ø	0005						

Figure 2-10.
MULTIUSE STANDARD REQUISITIONING/ISSUE SYSTEM DOCUMENT

STANDARD FORM 344
JAN 1972 EDITION
GENERAL SERVICES ADMINISTRATION
FPMR (41 CFR) 101-26.2

2.2.2.2. Updating and Maintenance of a Master Cover Index

A Master Cover Index depicting area coverage of the data base imagery holdings was updated and maintained throughout the tenure of the contract. All imagery plot sheets were keyed to AMS Series and V502 Series, 1:250,000 scale charts as a base for the master trace. The mission plots were traced on clear acetate material, keyed to the appropriate chart, and microfilmed with a 35mm Recordak microfilm camera on a reduction of 21X. Once the microfilm was processed, it was placed in microfilm jackets and filed in a retrievable manner in alphanumerical order according to chart designation. Personnel utilizing the data base viewed the microfilm products on a 3M Consultant 119, 35mm Microfiche reader with an 11.5X and a 24X lens.

The Master Cover Index was initiated by the RRC program staff under USAF Contract F30602-75-C-0172. Since its initiation, it has proved to be a valuable resource in aiding the data base user to retrieve desired imagery more rapidly and effectively. In addition, this type of Master Cover Index:

a. Offers easy data handling,
b. Requires little storage space,
c. Offers easy viewing on the Recordak Magnaprint Reader, and
d. Allows a hard copy record to be made if needed.

2.2.2.3. Data Base Services, Update and Maintenance

Once raw data were reduced and incorporated into the data base storage and retrieval system, project team members assisted all users in their retrieval of desired information. Requests varied widely in nature from a simple map order to a detailed interpretation and extraction of specific target information from a roll of imagery. Written requests that were approved by the appropriate authority have been satisfied throughout the tenure of the contract. The majority of requests were for multisensor imagery examples and various types of targets and target scenes on conventional aerial photography, and on thermal infrared and side-looking-radar imagery. A total of 307 visitors utilized the data base, and more than 300 data requests were filled over this twenty-five month program period.

At the onset of the contract, methods to improve the layout of the entire 40' x 60' data base were identified and employed to allow cleaner and more efficient storage areas, more security control over materials, and more secluded and roomy working space for data base users and data base staff.

The data base facility was continually maintained and updated. Proper security classification and downgrading of roll film and documents were accomplished in accordance with AFR 205-1 and DOD 5200-1-R. All data that were of little value or not relevant to current or future R&D programs were deleted from the data base storage and retrieval system.

2.3. TASK III - FLIGHT TEST PLANNING AND COORDINATION

Assistance in the area of flight planning was provided throughout the term of the program. Support in planning mission was provided by:

- o Supplying the requesting engineer with the appropriate charts overprinted with the necessary flight lines to obtain the area coverage desired.
- o Researching sensor operating parameters for the engineer when requested.
- o Assisting in determining the appropriate aircraft attitude, sensor system settings, film/filter combinations, and amount of film needed to adequately fly the mission. Table 2-3 is the standard formula used when planning aerial photo missions. Figure 2-11 is an example of an RADC Flight Profile Sheet that was provided for each mission flown.
- o Briefing and debriefing aircrews.

Figures shown in Table 2-4 represent the number of days per month with 10% cloud cover or less, and that are therefore suitable for acquiring aerial photography in New York State.

Figure 2-12 depicts the entire sensor test mission cycle.

MISSION PLANNING FORMULA

PARAMETER TO BE FOUND	FORMULA
GROUND COVERAGE (STATUTE MILES) (SINGLE VERTICAL PHOTO)	$G = \frac{H \times P}{5{,}280 \times f}$
NUMBER OF FLIGHT LINES REQUIRED	$n = \frac{\frac{W - G}{G(\frac{100-SL}{100})}}{} + 1$
CYCLE RATE (FRAMES/SECOND)/ INTERVALOMETER SETTING	$R = (\frac{1.69 \times V \times f}{P_s \times H}) \times (\frac{100}{100-OV})$
	$R \quad 1 \quad = \quad IS$
FILM USAGE RATE (FEET/MILE)	$Fpm = (\frac{f}{H}) \times (\frac{PL}{P_s}) \times (\frac{100}{100-OV}) \times (506.3)$

KEY

G	=	Ground Coverage Per Exposure (Statute Mile)
P_s	=	Film Format Short Side (Inches)
f	=	Focal Length (Inches)
n	=	Number of Flight Lines Required
W	=	Width of Area (Statute Miles)
SL	=	Sidelap Percentage
R	=	Cycle Rate (Frames/Second)
V	=	Aircraft Ground Speed in Knots
H	=	Aircraft Altitude (AGL)
OV	=	Overlap Percentage
IS	=	Intervalometer Setting
Fpm	=	Film Usage Rate (Feet/mile)
PL	=	Film Format Long Side (inches) to include distance between frames

Table 2-3

RADC FLIGHT PROFILE

page 1 of 1

DATE: AIRCRAFT: C-141 MISSION #: GR 78-001

COMMENTS:

TARGET	MAP REF.	FLT. LINE	ALTITUDE	OTHER
Stockbridge Test Site	1	1-4	3,000' AGL	4,275' AMSL
Stockbridge Test Site	1	1-3	6,000' AGL	7,275' AMSL
Stockbridge Test Site	1	1-2	10,000' AGL	11,275' AMSL
Stockbridge Test Site	1	1	15,000' AGL	16,275' AMSL
Griffiss AFB	2	1-3	5,000' AGL	5,504' AMSL
Griffiss AFB	2	1	10,000' AGL	11,504' AMSL
NETA Central Corr	3	1-6	12,000' AGL	12,760' AMSL

MAP REFERENCES

NUMBER	DESCRIPTION
1	Engineering Drawing of Stockbridge Test Site
2	AMS 1:250,000 Map - Sheet #NK 18-2
3	TPC 1:500,000 Chart - Sheet #F19D

Figure 2-11. RADC Flight Profile

JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
2.3	2.8	4.1	4.8	5.5	4.8	4.8	4.7	5.5	5.1	2.5	2.0

FIGURES SHOWN REPRESENT THE NUMBER OF DAYS PER MONTH WITH 10 PERCENT CLOUD COVER OR LESS. AVERAGES SHOULD BE USED WITH DISCRETION. AS WIDE VARIATIONS MAY OCCUR FROM ONE PART OF A STATE TO ANOTHER. FOR EXAMPLE, IF WE TAKE THE STATIONS BINGHAMTON, ALBANY, SYRACUSE AND WATERTOWN WE FIND FOR THE MONTH OF SEPTEMBER THAT ONE COULD EXPECT 0.6 CLOUD COVER OR GREATER (AT 1500 FEET) 15%, 32%,24%, AND 6% OF THE TIME RESPECTIVELY.

Table 2-4

WEATHER CONSIDERATIONS
COMPILED FROM U.S. WEATHER BUREAU RECORDS

2.4. NORTHEAST TEST AREA (NETA) SUPPORT

The Northeast Test Area satisfies the need for a temperate zone sensor test area. Centered in New York State, the NETA facilities reconnaissance study of industrial and military complexes, communications systems, and topographical features representative of world temperate

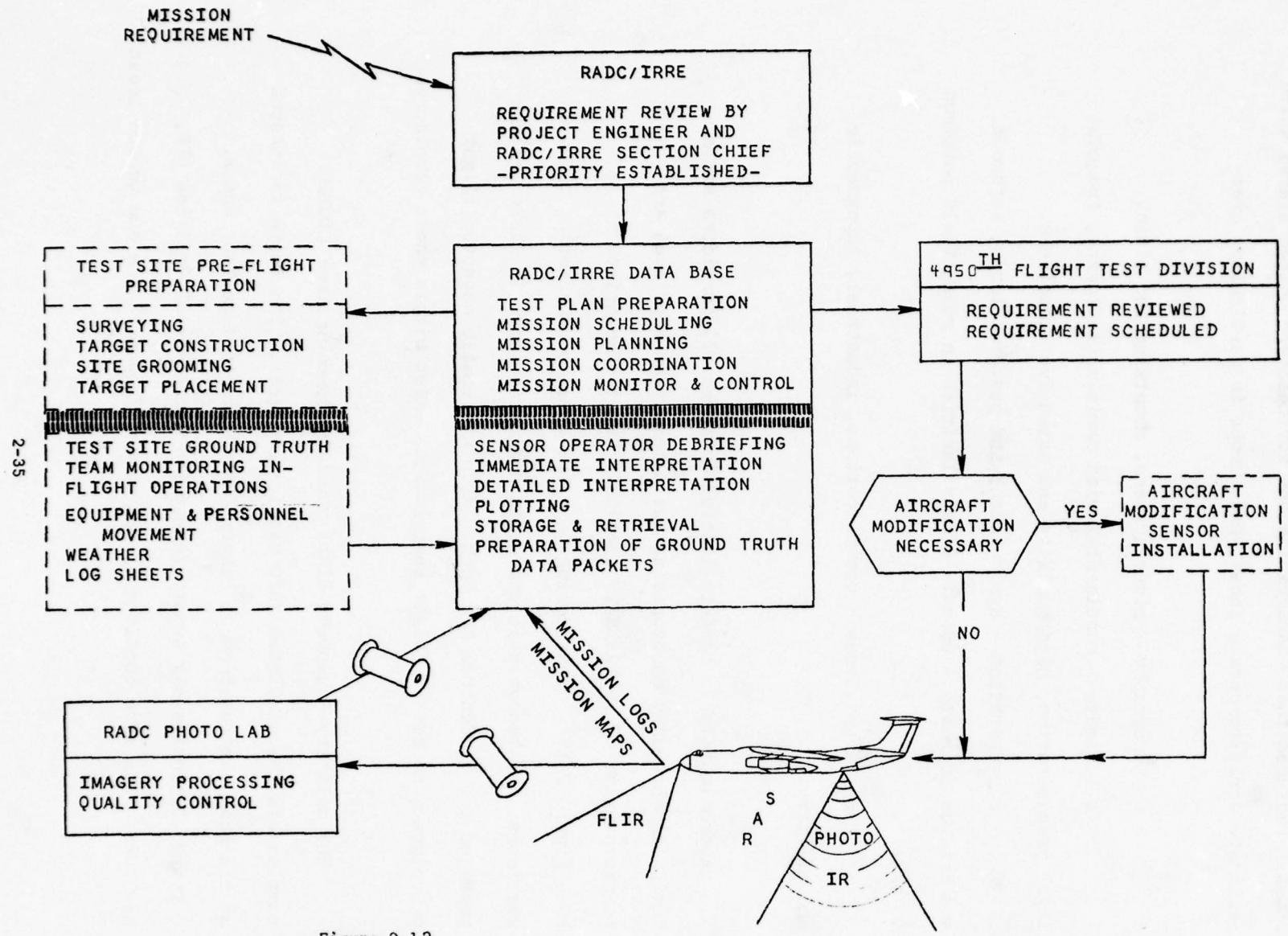


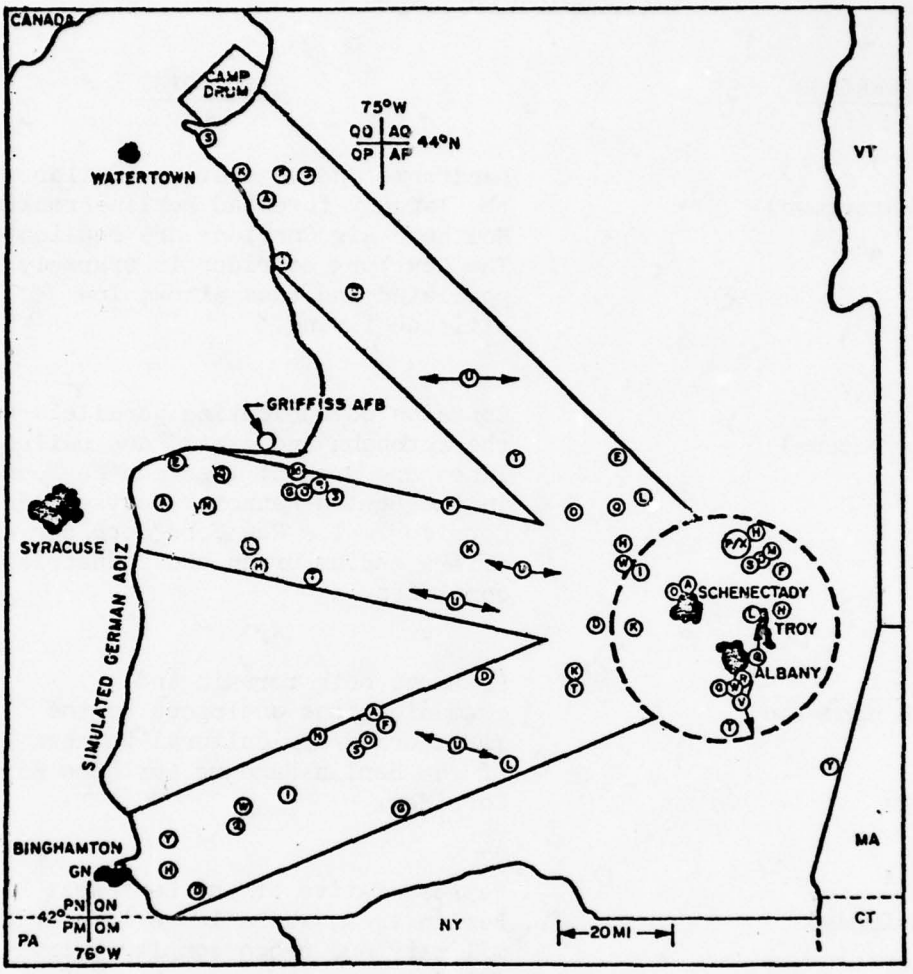
Figure 2-12.
SENSOR TEST/MISSION CYCLE FLOW DIAGRAM

zones. Features that characterize the Northeastern United States which replicate world temperate zones, and Europe in particular, are:

- o Topography - river systems, mountains and plains,
- o Climate - continental with maritime influence, frequent light precipitation, high humidity and extensive cloudiness,
- o Vegetation - agricultural and pastoral lands, softwood and hardwood forests - (Note: Dissimilarities in rural field patterns do exist),
- o Target Types - communications, industrial, topographic and military.

Approximately 72 targets located in three (3) corridors and a designated boundary encompassing the Albany, New York area are representative of the 25 NATO tactical target categories. (See Figure 2-13). Considering only the areal boundaries of these corridors, the topographic and urban analogies shown in Table 2-5 are provided for in Central New York. Within normally accepted flight procedures, no severe flight restrictions exist within these corridors.

The Military Equipment Display and Engineering Area (MEDEA) complements the simulated NATO tactical targets. The MEDEA is located at the Rome Air Development Center (RADC) Stockbridge Test Annex, situated approximately twenty-four miles southwest of Griffiss AFB, New York. The site consists of 500 acres of open fields and wooded areas



NATO Tactical Target Categories

A – Airfields
B – Bomb Damage Assessment (Conventional) None Available
C – Bomb Damage Assessment (Nuclear)
D – Bridges
E – Coastal Strips
F – Dam/Hydro-Electric Power
G – Electric Power Substations
H – Electronics
I – Ferries and River Crossings
J – Gun Emplacements/Positions
K – Helicopter Landing Areas/Troop and Drop Zones
L – Industries
M – Locks
N – Military/Government Control Centers
O – Military Installations
P – Missiles
Q – POL
R – Ports/Harbours
S – Rail Facilities
T – Road Junctions
U – Route Reconnaissance
V – Shipping
W – Thermal Power Plants
X – Troop/Vehicle Activity
Y – Tunnels

Figure 2-13. Location of NATO Tactical Targets
NETA Air Corridors

AIR CORRIDOR ANALOGIES

CORRIDOR	ANALOGIES
NORTH (Albany - Watertown)	Landforms and vegetation similar to the largely forested Berlin-Frankfurt Southern Air Corridor are replicated. The New York Corridor is sparsely populated and thus allows low altitude flying.
CENTRAL (Albany - Syracuse)	Contains communication parallels for the autobahn and canal, and railroad lines are present that can be found in the Berlin-Hannover Central Air Corridor. The New York Corridor also offers medium urban and industrial complexes.
SOUTH (Albany - Binghamton)	Features both terrain and communications analogous to the small urban/agricultural pattern of the Berlin-Hamburg Northern Air Corridor.
RING (Albany Environs)	Representative of the East-West Berlin area, where large industrial, military and urban complexes are found.
OPEN ENDS of Each Corridor (Watertown - Syracuse - Binghamton)	The cities are analogous to the large and small industrial complexes of Hamburg, Hannover and Frankfurt.

Table 2-5

positioned on the crest of a north-south oriented spur 800 feet above the surrounding terrain. Using this site to provide a tactical setting, realistic target groups that may pose a threat in a battlefield situation have been positioned throughout the site. Target groups include:

- SAM SITE (Simulated SA-3)
- AAA BATTERY
- MORTAR BATTERY
- HEAVY FIELD ARTILLERY BATTERY
- MOBILE SSM SITE
- ARMORED UNIT (To include a dummy tank)
- ASSAULT BRIDGE ENGINEER UNIT
- MILITARY VEHICLE CONVOY
- FORWARD TACTICAL SUPPLY POINT
- TACTICAL COMMAND POST FIELD HEADQUARTERS

Specific tactical equipment types are identified in Table 2-6. Throughout the contract, this equipment was positioned in various configurations to support a number of flight test programs.

In addition to tactical military equipment, a variety of radar resolution arrays and test pads are available and are surveyed into position for side-looking-airborne radar (SLR) tests. (See Figure 2-14).

TACTICAL EQUIPMENT

Armor

3 M48 Tanks
1 M59 APC
2 M84 APC's
1 M44 SP Gun
3 M55 SP Guns
1 M48 Dummy Tank

Wheeled Vehicles

20 1/4 T M38 (Jeeps)
7 2-1/2 T Trucks (Box Body)
13 2-1/2 T Trucks (Cargo)
3 2-1/2 T Trucks (Tankers)
1 5 T Truck with Honest John Missile

AAA

1 90mm AA Gun
2 40mm AA Guns
1 40mm Dummy AA Gun
1 Radar Trailer

SAM

2 Radar Trailers
1 Radar Antenna (on wheels)
1 Generator, Trailer Mounted

Artillery

3 8" Cannon
2 Snowcats
1 1-1/2 T Cargo Trailer

Engineering

1 14' Boat
1 Flatbed Trailer
1 Crane
1 200 Gallon Water Trailer

V/STOL

1 V/STOL Aircraft Silouette
1 Generator, Trailer Mounted

Table 2-6

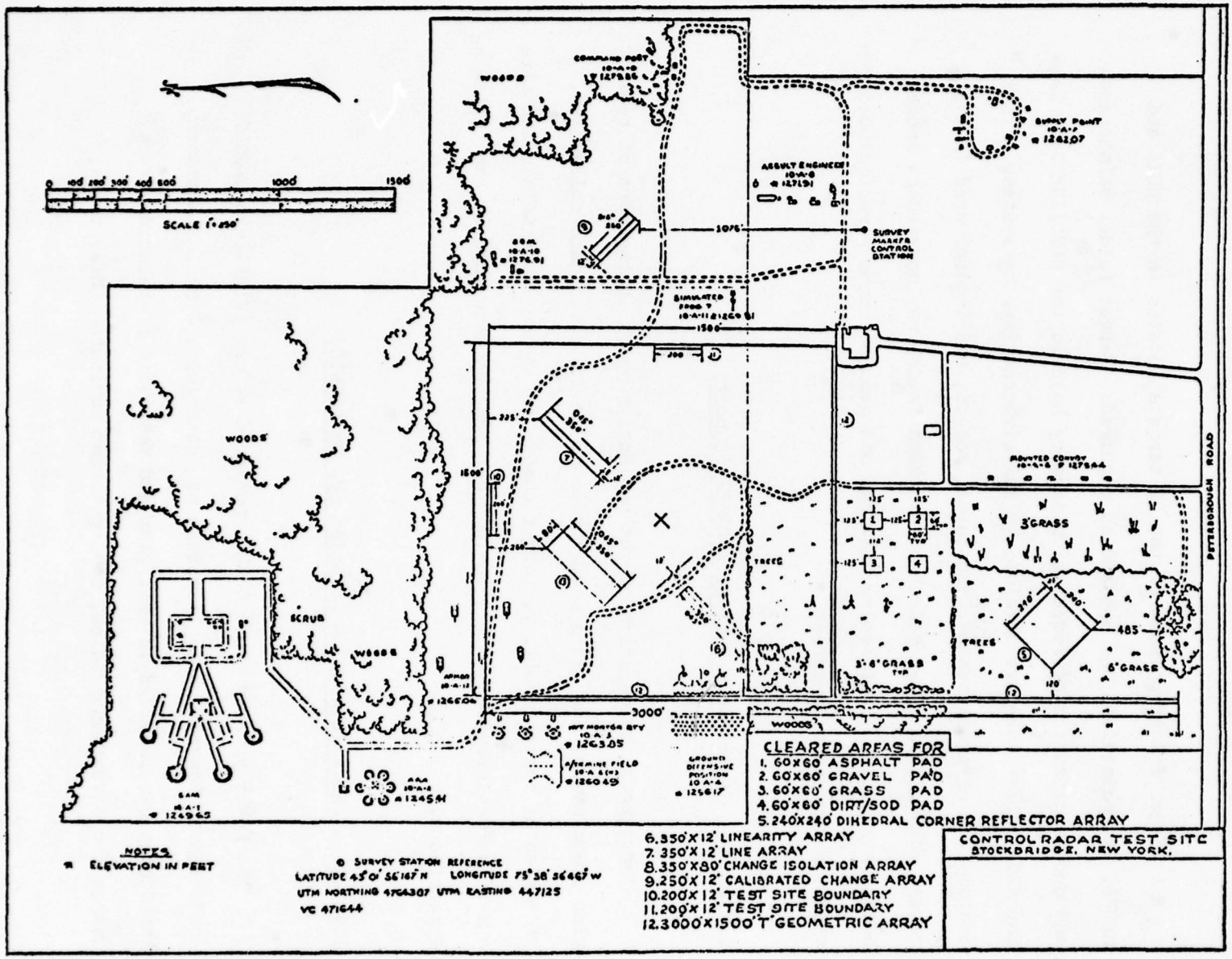


Figure 2-14. Stockbridge Control Radar Test Site

2.4.1. NATO Target Folder Maintenance and Update

A target folder on each of the 72 targets located in the NETA and MEDEA, was maintained and updated as required. Target folder maintenance and update consisted of researching imagery held in the RADC/IRR Data Base for NETA target coverage obtained by all airborne imaging systems. This imagery was printed, scaled, annotated, logged, and incorporated in the target folder in its own sensor pack. Each folder was updated as imagery became available. Engineering drawings and ground photos were included for specific targets of interest.

2.4.2. Stockbridge Test Site/MEDEA Support

Throughout the duration of the project, support in the form of test plan preparation, test site configuration, ground truth data collection, provision of target mobility, target change for detection studies, and site surveying was provided to aid in the test program described in the following subsections.

2.4.2.1. Hostile Weapons Location System (HOWLS)

The HOWLS program was a DARPA sponsored effort (F19628-76-C-0002) conducted by Massachusetts Institute of Technology, Lincoln Laboratory. Assistance was provided in test plan and test site preparation, target change for detection studies, moving target indicator (MTI) tests,

surveying, test site configuration, and ground truth data collection. Below are brief descriptions of specific tasks performed prior to and during Experimental Airborne Radar Tests over the MEDEA:

o Surveying and positioning of the following corner reflector arrays in accordance with a pre-established test plan. (Figure 2-15).

oo Calibration Corner Reflector Arrays

Arrays C1 - C4 were deployed according to test plan and positioned to minimize blockage and multipath.

oo Interference Arrays

IR1 - IR6 are "interference" geometries which allow analysis of the non-coherent high range resolution processing. Reflector arrays are visible from both south and west and consist of unresolved range spacings of 3, 10, and 20 dBsm corner reflectors in two levels of clutter (short grass/dirt and tall grass/bushes).

I01 - I06 are "interference" geometries which allow analysis of the non-coherent "SAR" processing. Reflector arrays are visible from the south only and consist of unresolved azimuth spacings of 4 and 6 m for 3, 10, and 20 dBsm corner reflectors in two levels of clutter.

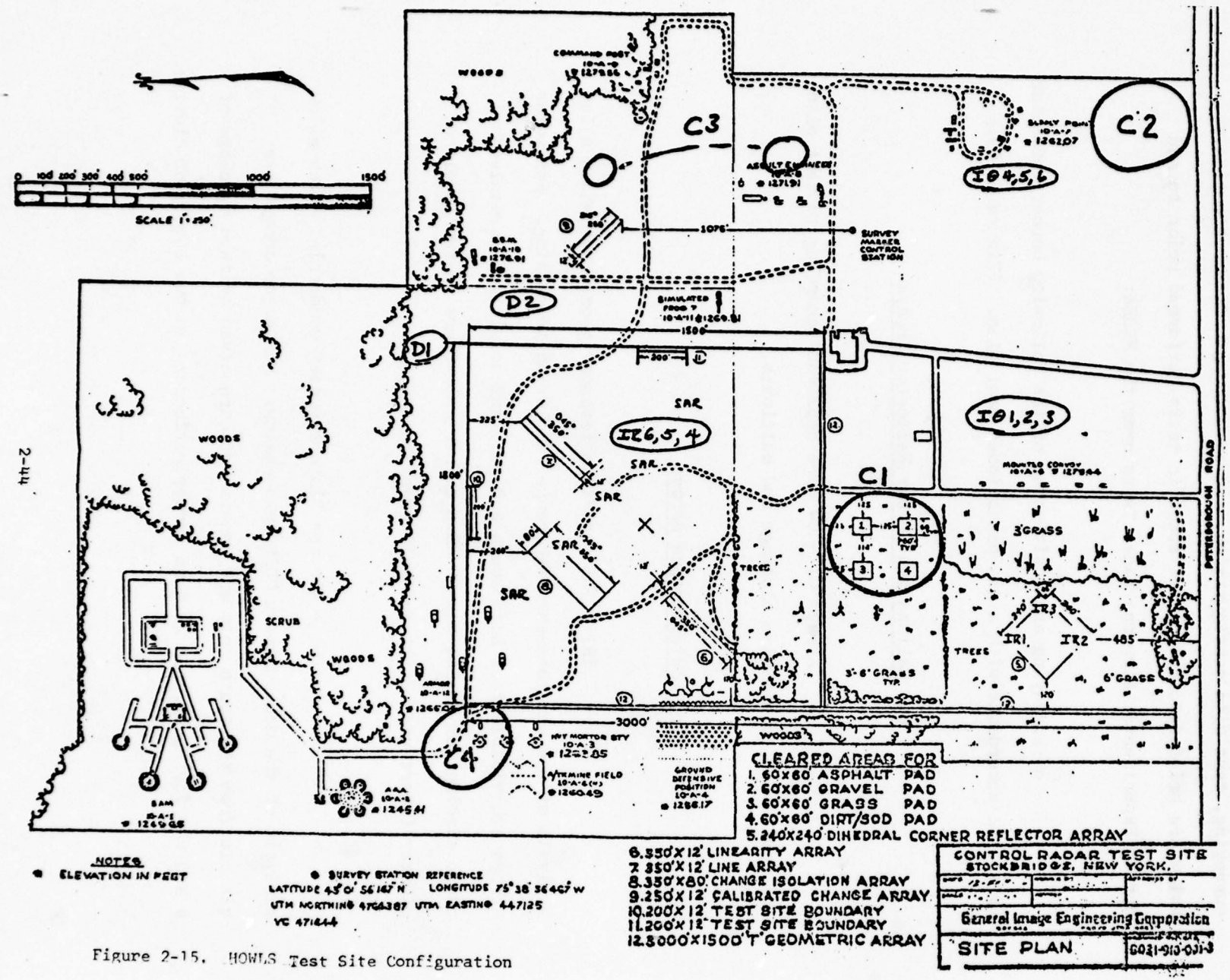


Figure 2-15. HOWLS Test Site Configuration

oo "T" Array

20S - 14W: Every other position to be 20 dBsm corner reflector facing south and remaining positions to be 14 dBsm corner reflectors facing west. Tilt angles should be 5^{o} below horizontal.

20W - 14S: Each of the above corner reflectors should be rotated 90^{o} resulting in 20 dBsm corner reflectors facing west and 14 dBsm corner reflectors south.

Note: The 2 northernmost reflectors (adjacent to tanks) should be omitted.

oo Clutter Discontinuity Arrays

D1, D2: When tests designated C13 - C18 are conducted, the geometries indicated in the attached figure were erected using available reflectors.

oo SAR Arrays

Standard configurations intact with IR4 - IR6 omitted. 40 dBsm reflector should be located 70 m SE of SPG with (4) 30 dBsm reflectors spaced on a diagonal between 40 dBsm reflector and "Honest John" missile (approximately 110 m spacing along the diagonal).

oo Tank Geometry

To provide greater angle diversity on the return from tanks, the attached tank geometry should be used.

The following corner reflectors were used for the HOWLS test:

8	each	30 dBsm
49	each	20 dBsm
20	each	10 dBsm
12	each	3 dBsm
29	each	14 dBsm
1	each	40 dBsm

o Movement of jeep array from Verona Test Site to Stockbridge.

oo The jeep array located at the Verona Test Site was moved to Stockbridge and surveyed into position in accordance with the HOWLS test plan.

o Positioning of Russian D-30 Field Gun and M-105 Howitzer.

oo A D-30 Russian Field Gun and an M-105 Howitzer was surveyed into position for HOWLS testing.

- o MTI Tests

  - oo Both tracked vehicles and wheeled vehicles were driven during the MTI portion of the tests.

- o Ground Truth Data

  - oo Engineering drawings were prepared on all tactical vehicle and reflector arrays upon completion of the tests.

2.4.2.2. Non-Pulse Emitter Identification Development (NPEID)

The primary support provided for this RADC program consisted of moving armor vehicles over a pre-designated test route during which time radio transmission/communication signatures were established. This task required two licensed armor vehicle operators during periods of testing.

2.4.2.3. Blackjack Testing

The objectives of this test were to:

- o Determine the acquisition capability of a 35 GHz Airborne Radar against an armor target in a variety of snow backgrounds.

o Determine the acquisition capability against a tank array.

o Measure K_a band radar backscatter levels from a variety of snow conditions.

Support for these tests included movement of armor vehicles during periods of overflights. In addition, the ground truth support team provided data pertaining to snow conditions in the target area, target information, and information on associated target backgrounds.

The sponsoring organization for the Blackjack tests was ASD/SD-31A, WPAFB, Ohio.

2.4.2.4. Precision Location Strike System (PLSS)

Radar corner reflectors and an armor array were positioned at the Stockbridge Test Site in support of this program. Survey data and ground truth drawings were provided to the test engineer.

This test was sponsored by RADC/DCIT and was undertaken to develop, design, and determine the feasibility of an emitter location system utilizing time difference of aerial and differential doppler technology.

2.4.2.5. Emitter Location System (ELS)

The objectives of this test were similar to the PLSS requirement. A corner reflector array was surveyed into position in accordance with

a specified test plan, (See Figure 2-16), and ground truth data was collected during periods of testing. Engineering drawings and survey data were provided to the test director.

2.4.2.6. Millimeter Wave Snow Measurement

This program was sponsored by the U.S. Army Armament Research and Development Command, U.S. Army Ballistics Laboratory (USA BRL), and the U.S.A.F. Armament Test Center (AFATC).

Measurements were taken off an M-60 tank driven on a specified route at the Verona Test Site.

A licensed tank driver was supplied during periods of testing in support of this effort.

2.4.2.7. CYCLOPS/SADARM (Seek and Destroy Armor)

This was a U.S. Army Ballistic Research Laboratory and U.S.A.F. Armament Test Center joint program designed to measure background and selected target signatures at a wavelength of 8.5 millimeters. All measurements were taken from a UH1M helicopter.

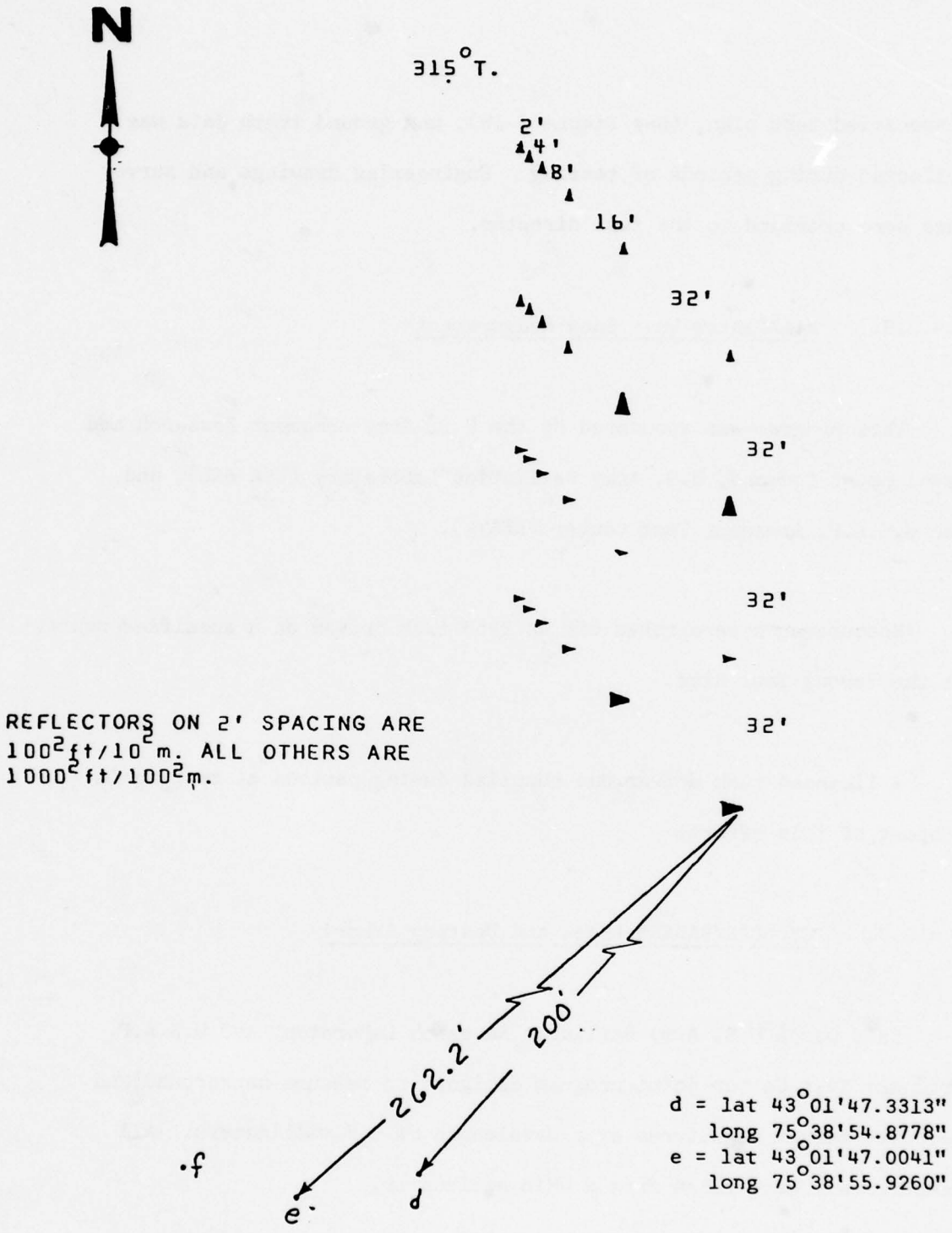


Figure 2-16. ELS Test Array

Support for this program was very extensive. Passive reflector arrays were surveyed into position along with various military vehicles. (See Figures 2-17 and 2-18). Ground truth data (to include snow measurements) were collected during periods of overflight.

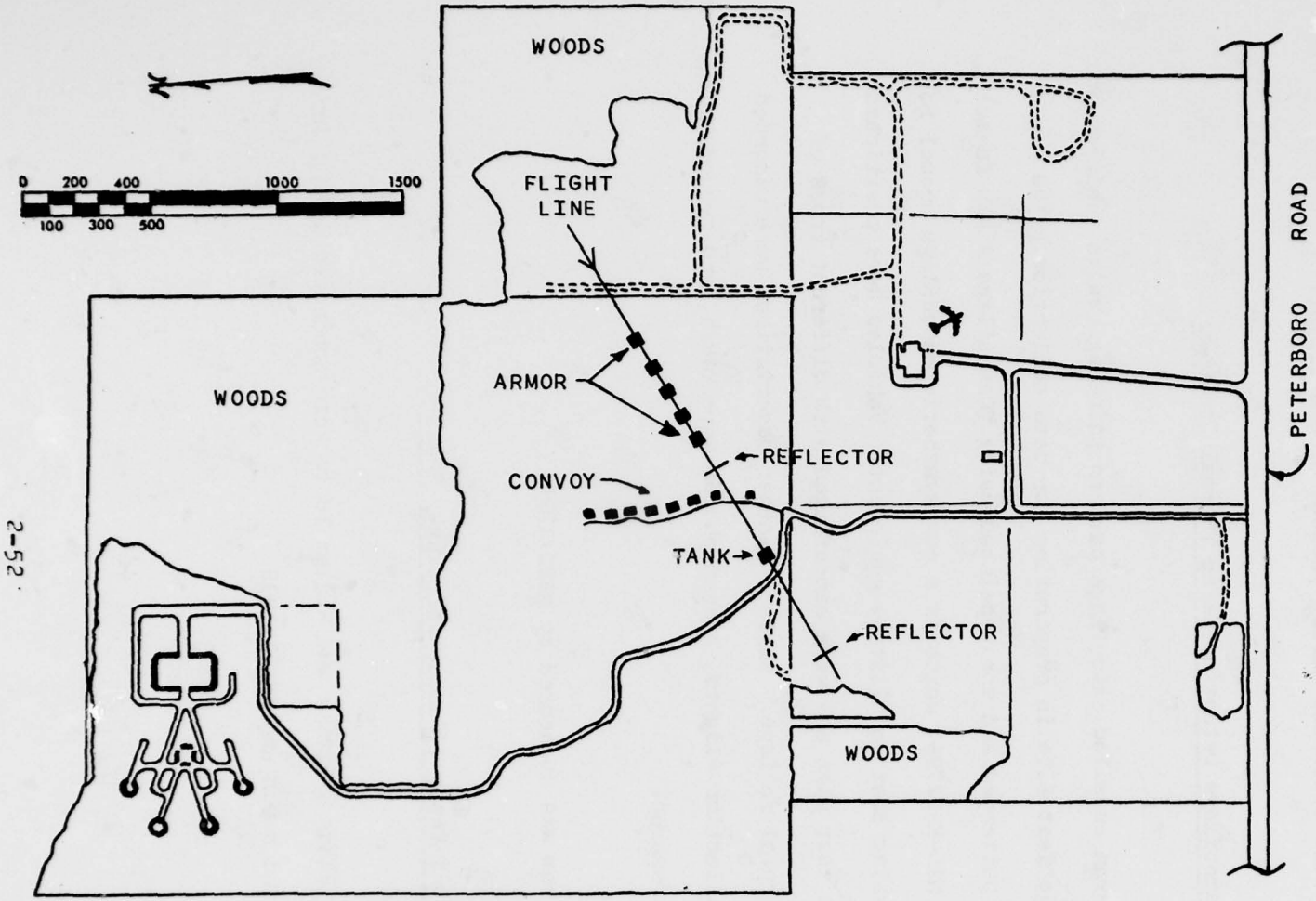
2.4.2.8. Camouflage Detection Using Thermal Contrast

This program entailed camouflage pattern painting twelve vehicles at the Stockbridge Test Site in preparation for data collection. The equipment was patterned and spray painted using "Camouflage ALKYD Enamel", Specification MIL-E-52798, which is a new synthetic camouflage enamel for use as a finishing coat on military equipment. Vehicles were positioned according to a test plan and were camouflaged with different types of netting and natural foliage. Surface weather observations were recorded during data collection flights, ground photos were taken, and ground truth packets were prepared.

This program was sponsored by RADC/IRRE.

2.4.2.9. UPD-X Phase I Summer and Winter Tests

The UPD-X Phase I Summer and Winter Tests were conducted during June and July 1977 and March and April 1978.

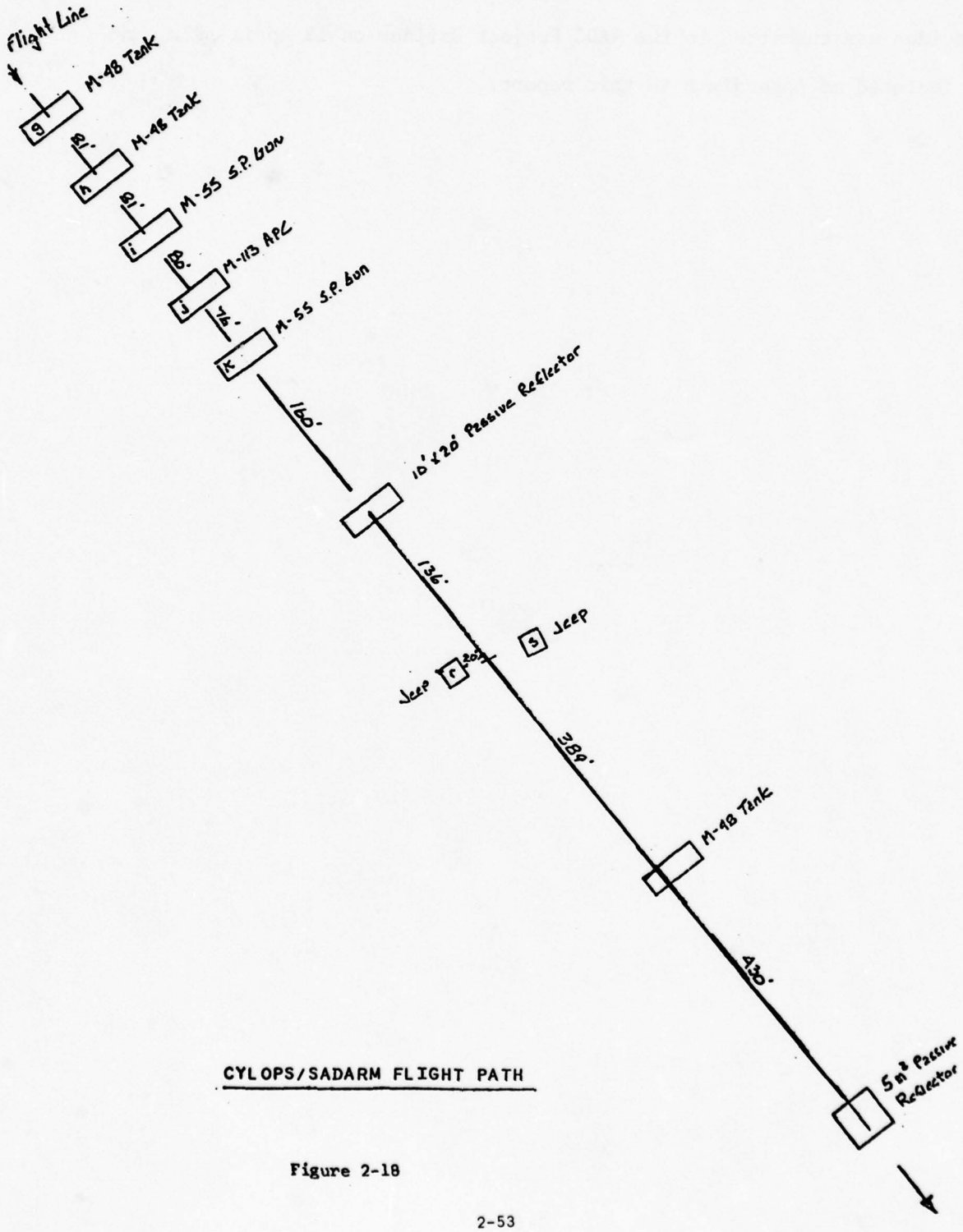


CYLOPS/SADARM TEST ARRAY

STOCKBRIDGE TEST SITE

Figure 2-17

Rome. Research Corp.
Rome, N.Y.



CYLOPS/SADARM FLIGHT PATH

Figure 2-18

Assistance was provided to the RADC Program Engineer in preparing a test plan for these tests. An in-depth interim report on the support provided was submitted to the RADC Project Officer on 19 April 1978, and is included as Appendix B to this report.

SECTION 3

CONCLUSIONS AND RECOMMENDATIONS

3.1. CONCLUSIONS

It is the conclusion of the program staff that the tasks identified in the Research and Technology Statement of Work have been completely satisfied. Useful results have been derived from the sensor evaluations conducted under Task I of the program. It is further concluded that:

(1) Mission planning support was an essential part of acquiring aerial photography in support of numerous R&D programs;

(2) Assistance rendered by the data base staff was invaluable in providing the necessary support required by RADC and other USAF and DOD programs; and

(3) The Northeast Test Area (NETA) and the Military Equipment Display and Engineering Area (MEDEA) located at the Stockbridge Test Site satisfied the long-existing need for a temperate zone sensor test area and was fully utilized throughout the course of the contractual effort.

3.1.1. Recommendations

Throughout the years, over 4,100 technical documents and imagery interpretation keys have been incorporated into the data base. In addition,

over 250,000 linear feet of roll film and various digital and video data tapes are maintained for use on R&D programs. The task of retrieving requested material is becoming a bit cumbersome because of the volume of data that must be researched. Automation of the current storage and retrieval system is the primary recommendation offered to improve the efficiency and value of the RADC/IRR Reconnaissance Data Base. The Rome Research Corporation program staff further recommends:

(1) Data base holdings and interpretive support should be reviewed on a regular basis to assure that these resources are being properly utilized in support of major RADC programs.

(2) Outdated material should be periodically purged from the data base system and should be replaced with current data.

(3) Equipment for viewing video tapes (such as Pave Tack FLIR) should be set up in the data base facilities for viewing and researching FLIR data. The IVC 825A Video Tape Recorder and the Conrac RQB-17 Video Monitor used during the Quick Strike Training/Orientation would adequately fill this requirement.

(4) A "News Letter" on the services and data available through the data base should be initiated and distributed periodically throughout RADC, and other appropriate U.S.A.F. organizations such as ASD, ESD, and AFSC.

(5) The imagery Master Cover Index should be maintained and updated on a regular basis.

(6) Consideration should be given to developing an additional sensor test complex for special sensor evaluations. A large number of programs have been supported at Stockbridge throughout the contractual effort. Other programs such as MRS^3/MASR, Wide Area Anti-Armor Munition (WAAM), and Camouflage Detection are scheduled to use the MEDEA at Stockbridge during this fiscal year.

(7) Portable photo and passive infrared resolution targets should be constructed. These targets could be positioned for certain sensor tests, and would contribute to the value of the MEDEA and the NETA. The use of Griffolyn T-55 and T-65 materials for these targets should be investigated. Reports indicate that this nylon reinforced plastic sheeting has been tested and proven to be economical for use by photogrammetry services.

(8) Because of the continuing surveying requirements associated with positioning of tactical type targets and corner reflector arrays, a theodolite (WILD T-2 or equivalent) should be procured for the Stockbridge Test Site.

(9) All equipment located within the MEDEA that has not been camouflage pattern painted should be sanded, primed, and painted using

Camouflage ALKYD Enamel, Specification MIL-E-52798. A steam cleaner and spray painting unit will be required to accomplish this task.

(10) Additional "Synthetic Woodland Radar Scattering Camouflage Nets" should be procured for use during future camouflage detection programs.

(11) Investigation into the possibility of acquiring additional salvage military equipment for use at Stockbridge. There currently exists a large requirement for armor type targets.

(12) The availability of the MEDEA should be advertised internally and to various DOD agencies to promote its use and increase funds for continued development and maintenance of the NETA.

APPENDIX A

AN/AAD-5 FIBER OPTIC FILM RECORDER (FOFR)
TEST PLAN

AN/AAD-5 FIBER OPTIC FILM RECORDER (FOFR)

TEST PLAN

1.0. INTRODUCTION

RADC has drafted this test guide to provide a document for evaluating Honeywell's Fiber Optic Film Recorder (FOFR) capability to record AN/AAD-5 data on dry silver film in a Quick Strike Reconnaissance environment.

2.0. TEST OBJECTIVE

This test shall determine the image recording capabilities of the Honeywell FOFR by comparing the imagery it has recorded to imagery received by QSR Laser Beam Recorder (LBR), using identical input.

3.0. GENERAL BACKGROUND

The Quick Strike Reconnaissance Program was established to design and test a day/night aerial reconnaissance system which would provide tactical commanders with near real-time intelligence information. This concept is realized by electromagnetically transmitting infrared data from an infrared sensored RF-4C aircraft to a ground station which consists of an antenna and Reconnaissance Reporting Facility (RRF). Within the RRF, the near real-time data is received, processed into a pictorial format (imagery) and exploited by Image Interpreters (II). The image interpreters,

upon exploiting the imagery, send a report to a Tactical Air Command Center (TACC) for further action. The QSR system is based on two different infrared subsystems: The Forward Looking Infrared (FLIR) and Downward Looking Infrared (AN/AAD-5). This test guide shall address the AN/AAD-5 subsystem.

An operational QSR system has been built and has finished Developmental Testing and Evaluation (DT&E) at Eglin AFB, FL; it is now in the process of Initial Operational Testing and Evaluation (IOT&E) until 30 September 1978. With the aid of data which is received from the DT&E/IOT&E, the QSR SPO will develop a Full Scale Development (FSD) model of the RRF prior to RRF production. The present QSR system in regards to the RRF and more particularly the recording of AN/AAD-5 imagery has up to this date been accomplished using a Laser Beam Recorder (LBR) developed by RCA. This unique instrument has made it possible to record imagery on dry silver film making it feasible to exploit hard copy AN/AAD-5 film in near real-time.

Honeywell Corporation, Lexington MA has been in the process of engineering a Fiber Optic Film Recorder (FOFR) which will record AN/AAD-5 imagery on dry silver film (FSN: 6750-165-7159 or equivalent). The Honeywell FOFR is now ready for test and evaluation in a QSR environment at Eglin AFB, FL. RADC has been tasked by ESD/DCME, Tactical Information Processing and Interpretation (TIPI) System Program Office (SPO) to determine the image recording capabilities of the Honeywell FOFR on dry silver film in a QSR environment.

4.0. DESCRIPTION OF TEST SET UP

The LBR and FOFR with respective processors will be set up in the QSR Hot Mock-up Configuration diagrammed in Figure 1. Each recorder shall receive identical input signals from the AN/AAD-5 demultiplexer located in the Receiving Shelter (RS) of the RRF. The QSR LBR shall not be moved from its present location in the Exploitation Shelter (ES). The Honeywell FOFR shall be located in the RS. The RCA and Honeywell contractors shall supply personnel to set up and fine tune their respective recorders for the test.

5.0. TIME TABLE

The following Time Table shall be followed for: the test set up, test coordination, testing, evaluation of test data, and preparation of the final report.

TIME TABLE

Date(s)	Action(s)
17 July 1978	Contractor and RADC personnel arrive at Eglin AFB FL.
18 July 1978	RADC-TAWC coordination meetings to begin.
18 July - 21 July	Honeywell to set up and interface FOFR into RS.
24 July - 4 August	Testing and evaluation of Honeywell FOFR image recording capability.
23 August	Draft of RADC's Final Report due for review.
4 September	Final Report completed.

6.0. TEST METHOD

The overall test shall be comprised of an Objective Test and a Subjective Test. Neither test shall interfere with the completion of QSR IOT&E test mission objectives. A description of each test follows. The overall test shall determine the image recording capabilities of the Honeywell FOFR by comparing the imagery it has recorded to the imagery recorded by the QSR LBR using identical AN/AAD-5 inputs. The RCA LBR imagery will be the minimum acceptable standard in this test.

1. Objective Test:

The purpose of the objective test is to provide data at controlled density and resolution values for objective measurements used to determine the FOFR image recording capabilities.

The objective test shall be accomplished by transmitting AN/AAD-5 test data over an electromagnetic data link from Hangar 68 to the FOFR and LBR located within the RRF. Two types of AN/AAD-5 test data shall be generated within the Hangar 68 Laboratory:

a. Simulated video which consists of a continuous frequency output with variable amplitudes at the following frequencies: 1.2 MHz, .625 MHz, .312 MHz, .156 MHz will be electronically generated using the electronic equipment within the laboratory. This will make it possible

to determine consistency of contrast over the width of the imagery. Figure 3 in the Annex is a data tabulation sheet for this test.

b. Receiver Bar Target Video will be generated by placing bar targets at various temperatures (up to 20°F directly below the focused AN/AAD-5 sensor located in the Hangar 68 Laboratory). Three (3) V/H values will be employed for each bar target. The three (3) V/H values will be:

(1) Low V/H (.05 to .20 millirad)

(2) Medium V/H (.20 to .40 millirad)

(3) High V/H (.40 to .60 millirad)

The bar targets will consist of the following sizes: 1/4 mil, 1/3 mil, 1/2 mil, 1 mil, and 2 mil. This test will determine the resolution and density which the FOFR is capable of achieving on dry silver film. Figure 4 in the Annex is a data tabulation sheet for this test.

2. Subjective Test:

The purpose of the subjective test is to determine the image recording capabilities of the FOFR using tactical targets for test data. From this test QSR Image Interpreter comments shall be recorded regarding the imagery, quality, number of targets detected, and number of targets identified.

The subjective test shall require the utilization of the RF-4C infrared sensored reconnaissance aircraft and RRF. This shall be accomplished by coordinating and working with TAWC on "live" QSR IOT&E test missions. This test shall require the AN/AAD-5 sensor in the RF-4C reconnaissance aircraft to be set in the Narrow Field of View. A total of 24 AN/AAD-5 passes is planned over two test sites. Twelve (12) passes will be flown over each of the following test sites:

a. Site B-71 comprised of static Armored Personnel Carriers (APC). Sterno cans will be used to simulate operating APCs for night test missions.

b. Site B-70 comprised of static APCs and tanks. Sterno cans will be used to simulate operating APCs and tanks for night test missions.

c. At an option, Site C-52 which contains an operable APC may be used. If this option is accepted, twelve (12) passes will be added to the data collected for a total of thirty-six (36) passes.
Of the 12 AN/AAD-5 passes flown over each of the three (3) test sites, the following parameters shall be attempted to be met.

(1) Six (6) out of the twelve (12) passes flown over each test site shall be during the day and six (6) at night. No passes flown 1/2 hour before or after the radiometric crossovers will be accepted.

(2) For each set of six (6) passes, three (3) passes shall be flown at an altitude of 500 feet, and three (3) passes flown at an altitude of 1,000 feet.

(3) For each subset of three (3) passes, the following V/H values shall be met:

a. Low V/H range (.05 to .20 rad/s)

b. Medium V/H range (.20 to .40 rad/s)

c. High V/H range (.40 to .60 rad/s)

A summary of the test mission parameters is diagrammed in Figure 2 of the Annex. Figures 5, 6, and 7 of the Annex are data tabulation sheets for this sheet. After the recording of imagery both in the Objective and Subjective Tests, contractors shall be allowed to inspect the test imagery recorded by their respective recorders. The contractors shall be given the choice to accept or not accept the imagery. If recorded test imagery is not accepted, the contractor shall be allowed to adjust his recorder to its optimum capability. Following the contractors recorder adjustment, the imagery shall be re-recorded until accepted by the contractor.

However, any imagery re-recording shall not be repeated more than two (2) times, i.e., the contractor must accept one out of three (3) image recordings from a particular pass. Re-recordings shall be by the QSR mission tapes and the Video Tape Recorder within the RS. QSR image interpreters will be employed to evaluate the accepted images. RADC will analyze, evaluate, and report to the Air Force the conclusions on this test.

7.0. VII TEST RESPONSIBILITIES

RADC will:

1. Coordinate with TAWC on QSR IOT&E test missions to be held 24 July 1978 through 4 August 1978, particularly those missions which share common test parameters.

2. Coordinate with TAWC on configuration of targets in the Under Brush Test Range.

3. Monitor and conduct the test with TAWC cooperation.

4. Record, analyze, evaluate, and report test data.

Honeywell will:

1. Integrate FOFR into QSR/RRF for test.

2. Provide personnel to set up and operate the FOFR.

3. Coordinate with RADC and TAWC test personnel on FOFR tests.

RCA will:

1. Provide personnel (at RCA's option) to set up and operate LBR during these tests.

ANNEX

KEY PERSONNEL

TAWC:

Lt Col Ramon Schapley (CTF Dir) AV 872-3831/5401

Maj Mike Morse (IOT&E) AV 872-3831/5401

Capt Benny Copeland (QSR Aircraft Dir) AV 872-3831/2957

Maj Larry Lauer (QSR RRF Dir)

SMSgt Peter Starin (QSR RRF On Site Manager) AV 872-3138/2957

TSgt Robert Lewis (II QSR/ES)

TSgt Charles Kunkle (II QSR/RS)

RADC:

2Lt Douglas J. Praska (FOFR Test Dir) AV 587-3095

Mr. Dick Petroski (RRC) AV 587-2935

Honeywell:

Mr. Dave Carlson (FOFR Proj Engr) (617) 862-6222 X658

Mr. Frank D'Arrigo (FOFR Engr)

Mr. Roger Stadine (FOFR Engr)

RCA:

Mr. Steve Corsover (LBR Proj Engr) (609) 338-3872

Mr. Heywood Weldon (LBR Engr) AC 872-5056

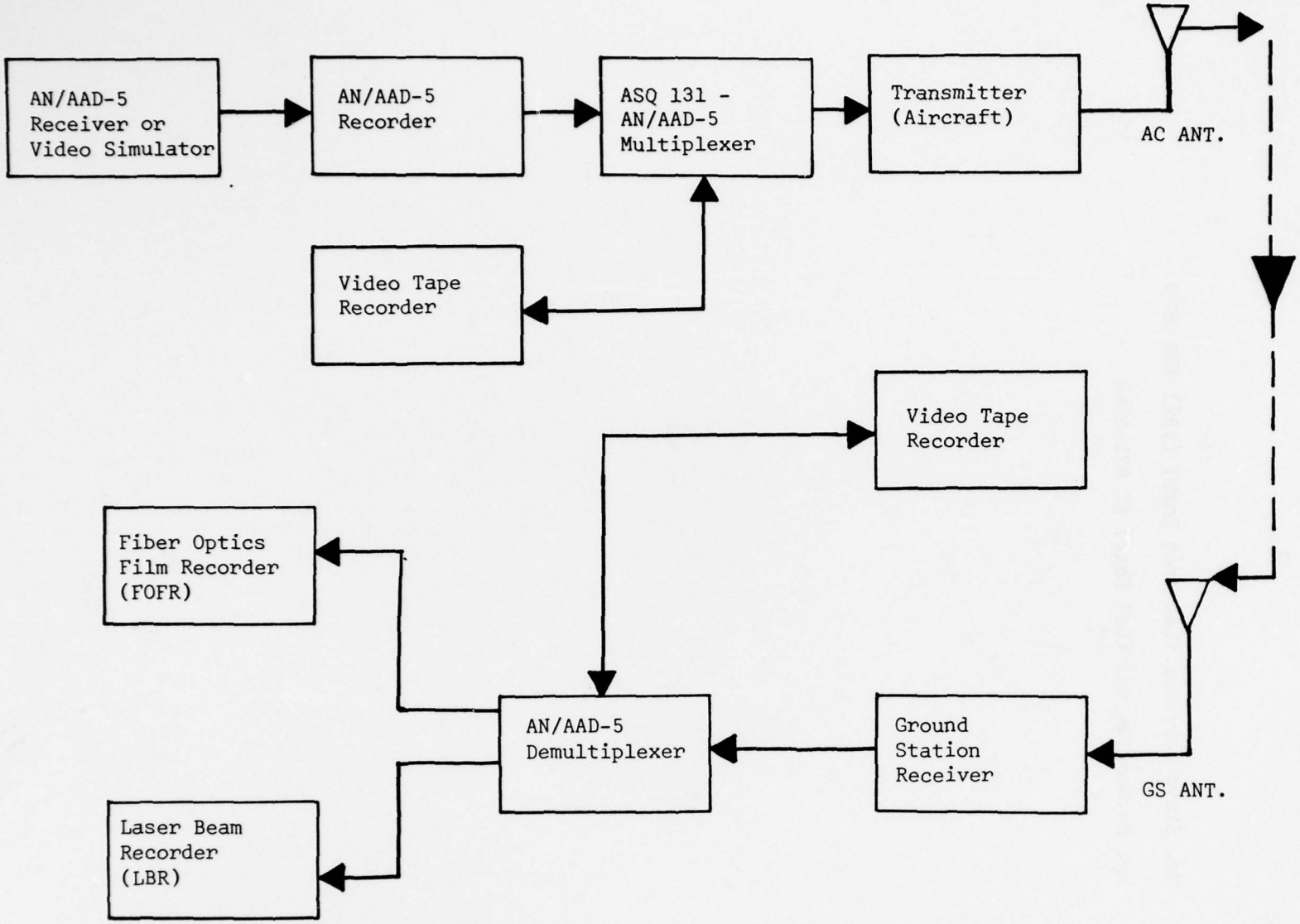


Figure 1. QSR Mockup Configuration

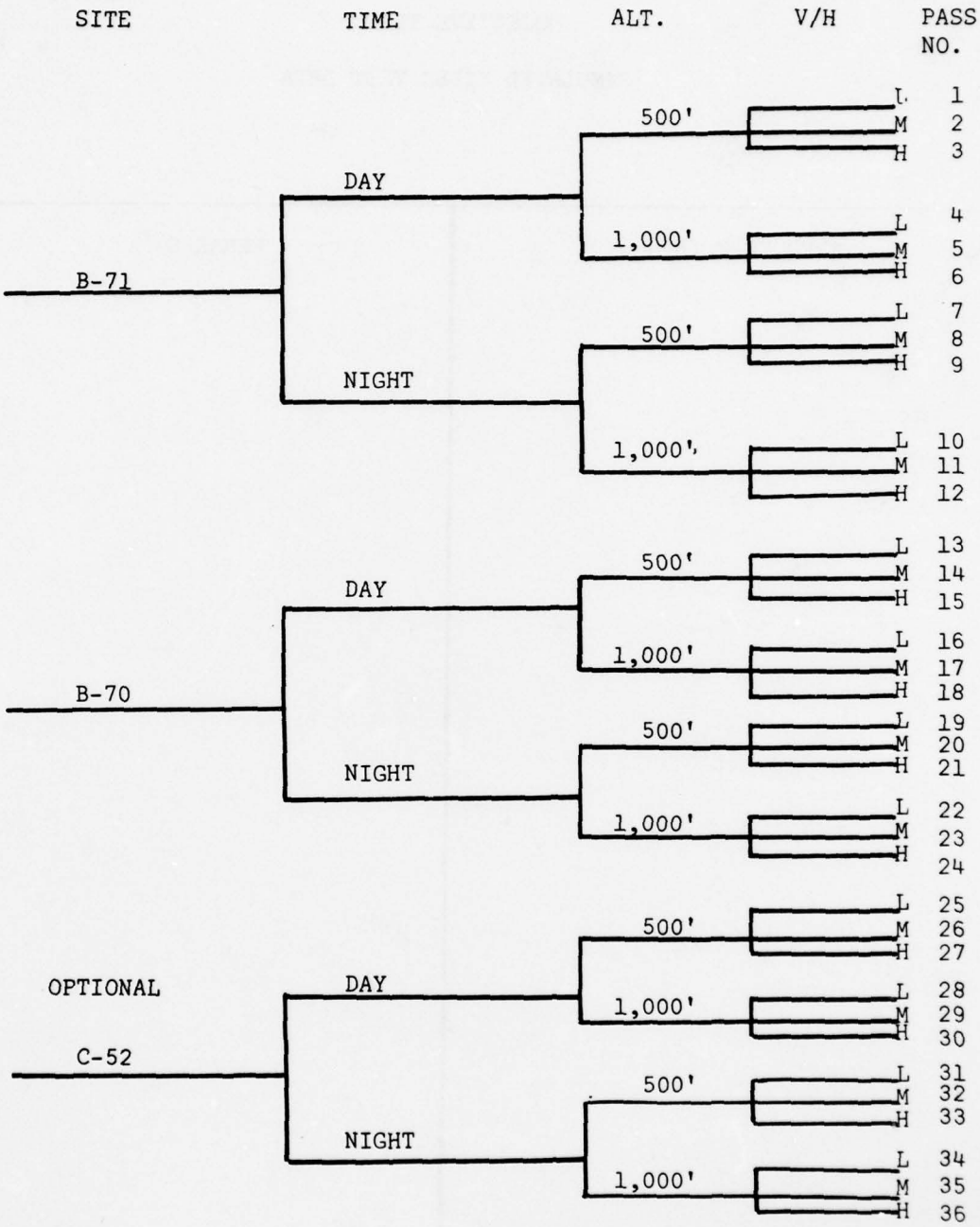


Figure 2. Subjective Test Description

OBJECTIVE TEST

SIMULATED VIDEO TEST DATA

FREQUENCY (Hz)	REMARKS

Figure 3

OBJECTIVE TEST

RECEIVER BAR TARGET VIDEO RESOLUTION

TEST DATA

PASS NUMBER	V/H	RESOLUTION (Milliradians)		REMARKS
		Across Track	Along Track	

NOTE: Dash indicates system cannot resolve target bars.

Figure 4

SUBJECTIVE TEST

TEST SITE B-71

TEST DATA

PASS NUMBER	TARGETS DETECTED	TARGETS IDENTIFIED	REMARKS

Figure 5

SUBJECTIVE TEST

TEST SITE B-70

TEST DATA

PASS NUMBER	TARGETS DETECTED	TARGETS IDENTIFIED	REMARKS

Figure 6

SUBJECTIVE TEST

TEST SITE C-52

TEST DATA

PASS NUMBER	TARGETS DETECTED	TARGETS IDENTIFIED	REMARKS

Figure 7

APPENDIX B

PREPARATION AND MAINTENANCE OF THE RADC STOCKBRIDGE TEST SITE FOR UPD-X PHASE I SUMMER AND WINTER TESTS

Contract F30602-76-C-0431

April 19, 1978

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RECONNAISSANCE SENSOR SYSTEM EXPLOITATION.(U)
MAR 79 R R PETROSKI F30602-76-C-0431
UNCLASSIFIED RRC-78-4 RADC-TR-79-32 NL

2 OF 3
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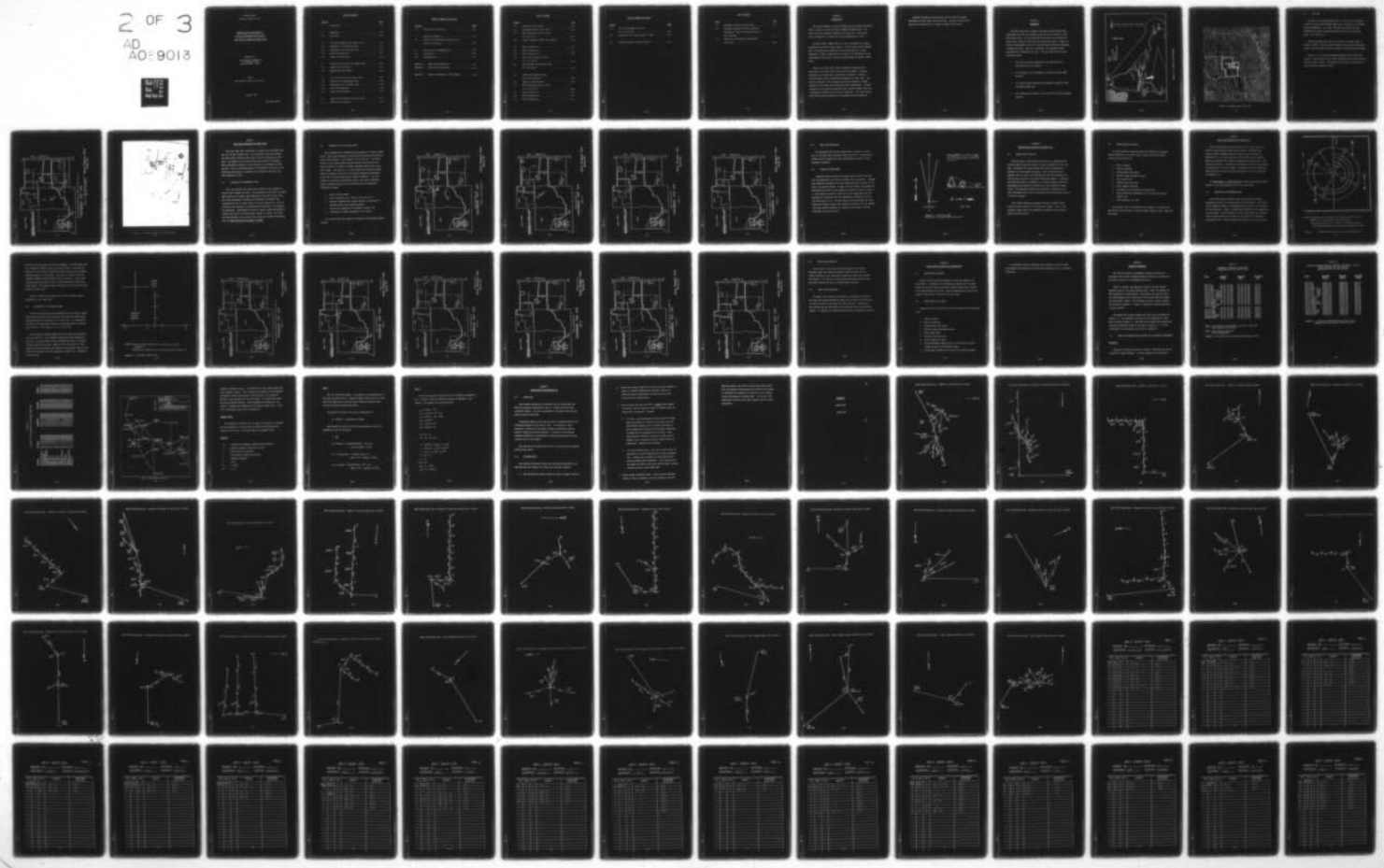

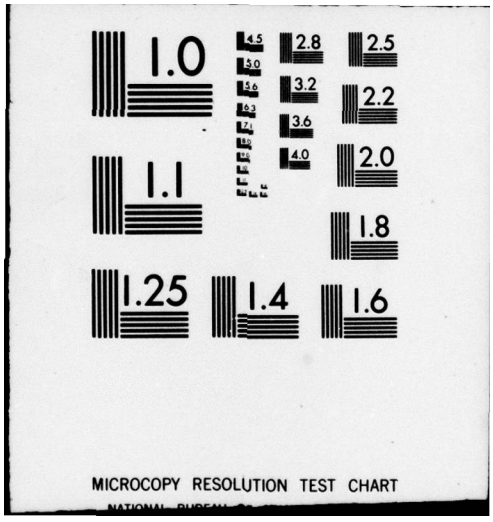
1.0
1.1
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1.4
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2.8
3.2
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4.0
4.5
5.0
5.6
6.3
7.1
MICROCOPY RESOLUTION TEST CHART

Interim Report

Contract F30602-76-C-0431

PREPARATION AND MAINTENANCE OF THE RADC STOCKBRIDGE TEST SITE FOR UPD-X PHASE I SUMMER AND WINTER TESTS

Submitted By

ROME RESEARCH CORPORATION
228 Liberty Plaza
Rome, New York 13440

Author

Reconnaissance Exploitation Group

19 April 1978

RRC Report #78-1

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SECTION 1

INTRODUCTION

This report documents the work performed by Rome Research Corporation (RRC) in support of the UPD-X PHASE I SUMMER AND WINTER TESTS. The summer tests were conducted during June and July 1977. Winter UPD-X testing commenced on 21 March 1978 and was terminated on 4 April.

The UPD-X PHASE I SUMMER TESTS were used to determine the optimal parameters for the UPD-X sensor system. The tests also offered adequate data to determine the capabilities of the system against a foliage background. Further testing was done to measure the performance of the UPD-X against snow-covered, winter conditions during the PHASE I WINTER TESTS.

Section 2 of this report offers background information and a description of the test site used for the UPD-X program. Test site preparation for summer tests is described in Section 3. Section 4 describes ground truth documentation procedures for these tests. Contained in Sections 5 and 6 respectively are the preparation methods employed for the winter tests and ground truth documentation. Geodetic information to include the procedures used to convert target survey data to geographic coordinates can be found in Section 7. The final section offers Rome Research Corporation's Conclusions and Recommendations.

Appendix A contains survey drawings and data sheets for target emplanement for both Summer and Winter Tests. Appendix B contains the Latitude and Longitude for all Summer and Winter Test Targets.

SECTION 2

BACKGROUND

The radar test complex located at the RADC Stockbridge Test Site, Stockbridge, New York, was selected as the test area for Phase I of the UPD-X summer tests. The site consists of 350 acres of open fields and wooded areas, seated 800 feet above the surrounding terrain. Figure 2-1 depicts the geographic location of the test complex within the boundaries of Upstate New York. Figure 2-2 illustrates the topographic relief surrounding the Stockbridge Test Site. This area was selected for the following reasons:

1. The site was readily available for the construction of a controlled radar test complex;

2. It is located in close proximity to Griffiss Air Force Base, New York;

3. Its terrain closely resembles the geographic conditions found in Central Europe, and

4. The climatology is similar to that found in the Central European environs.

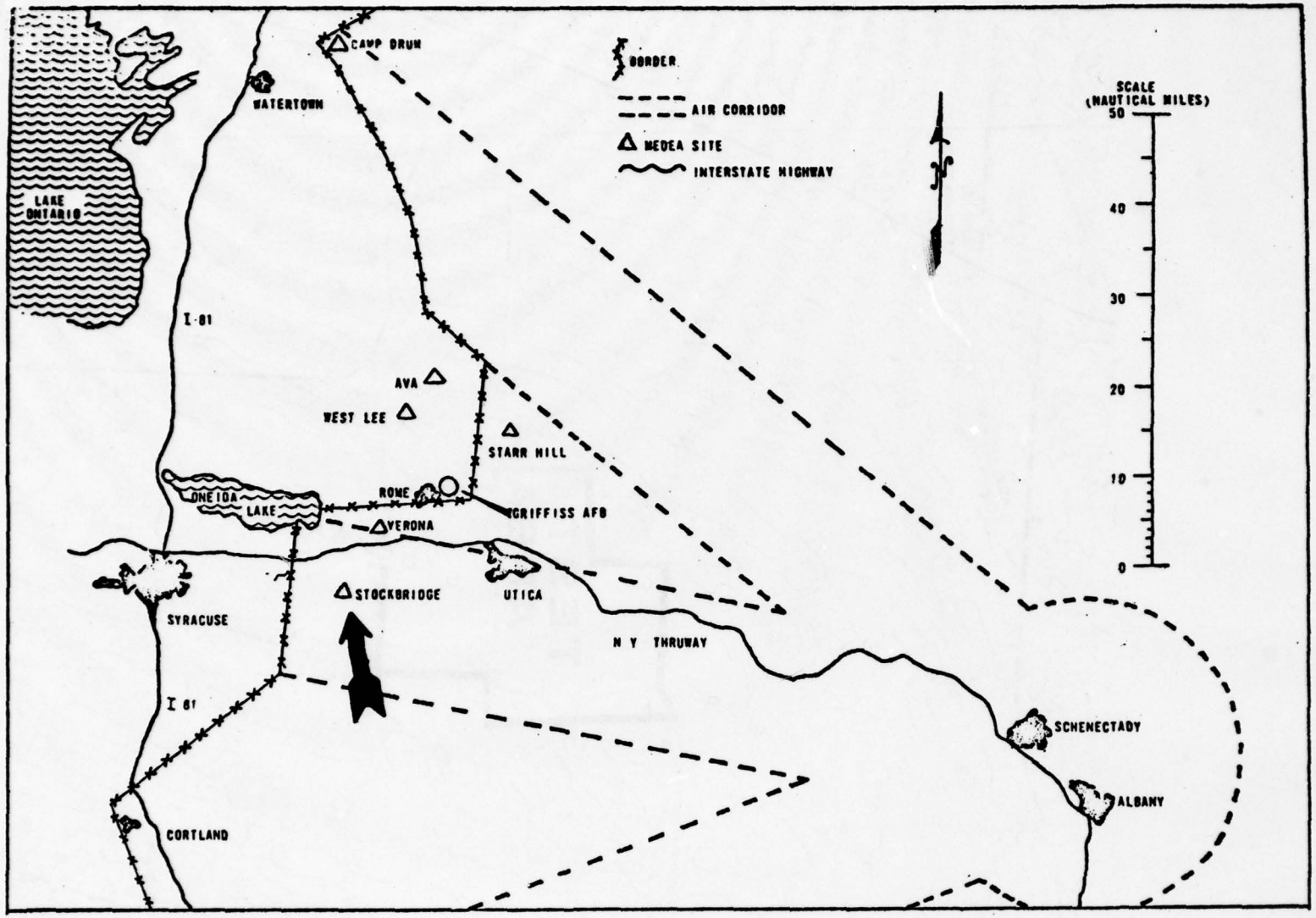


Figure 2-1 Location of Test Complex

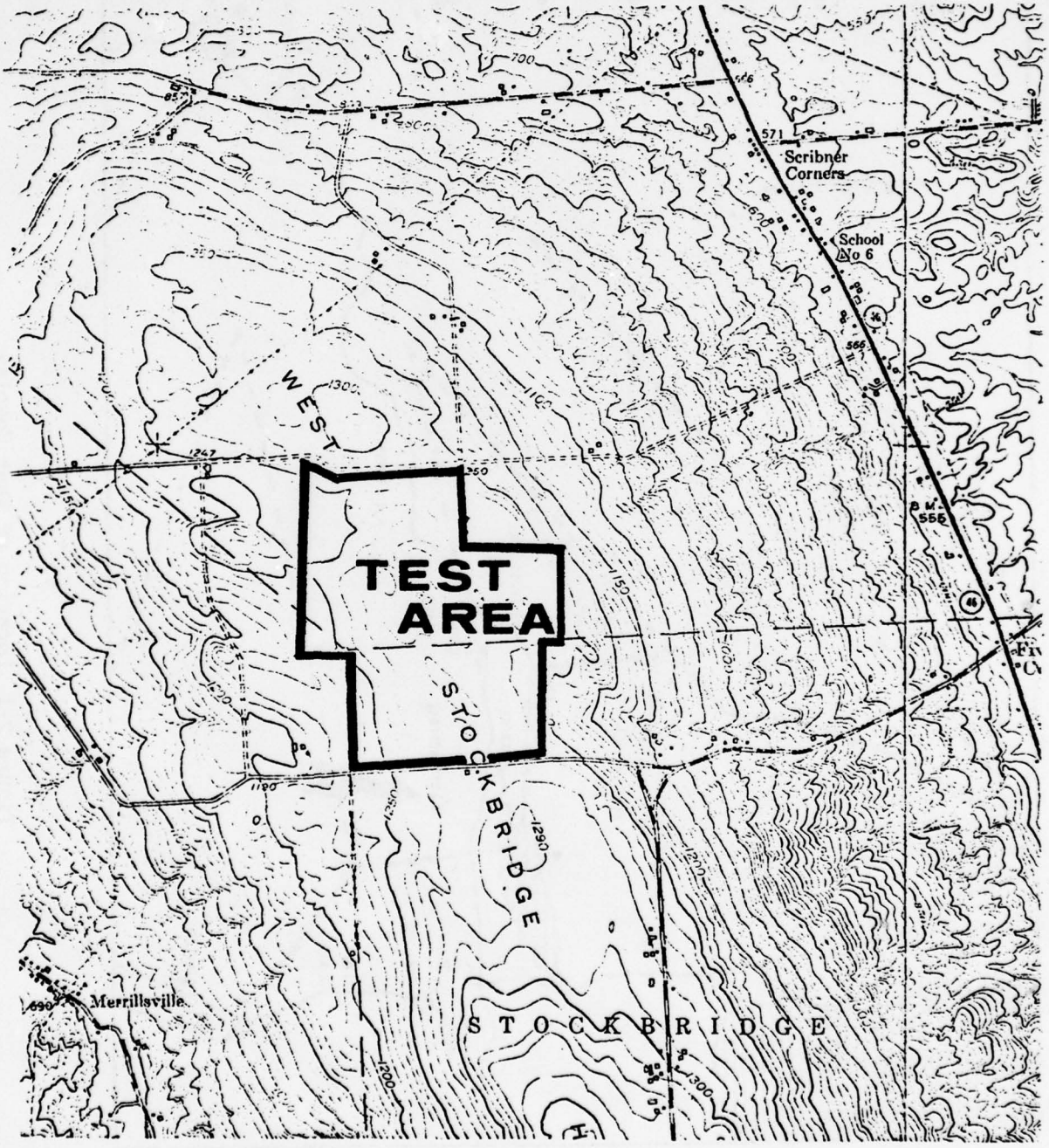


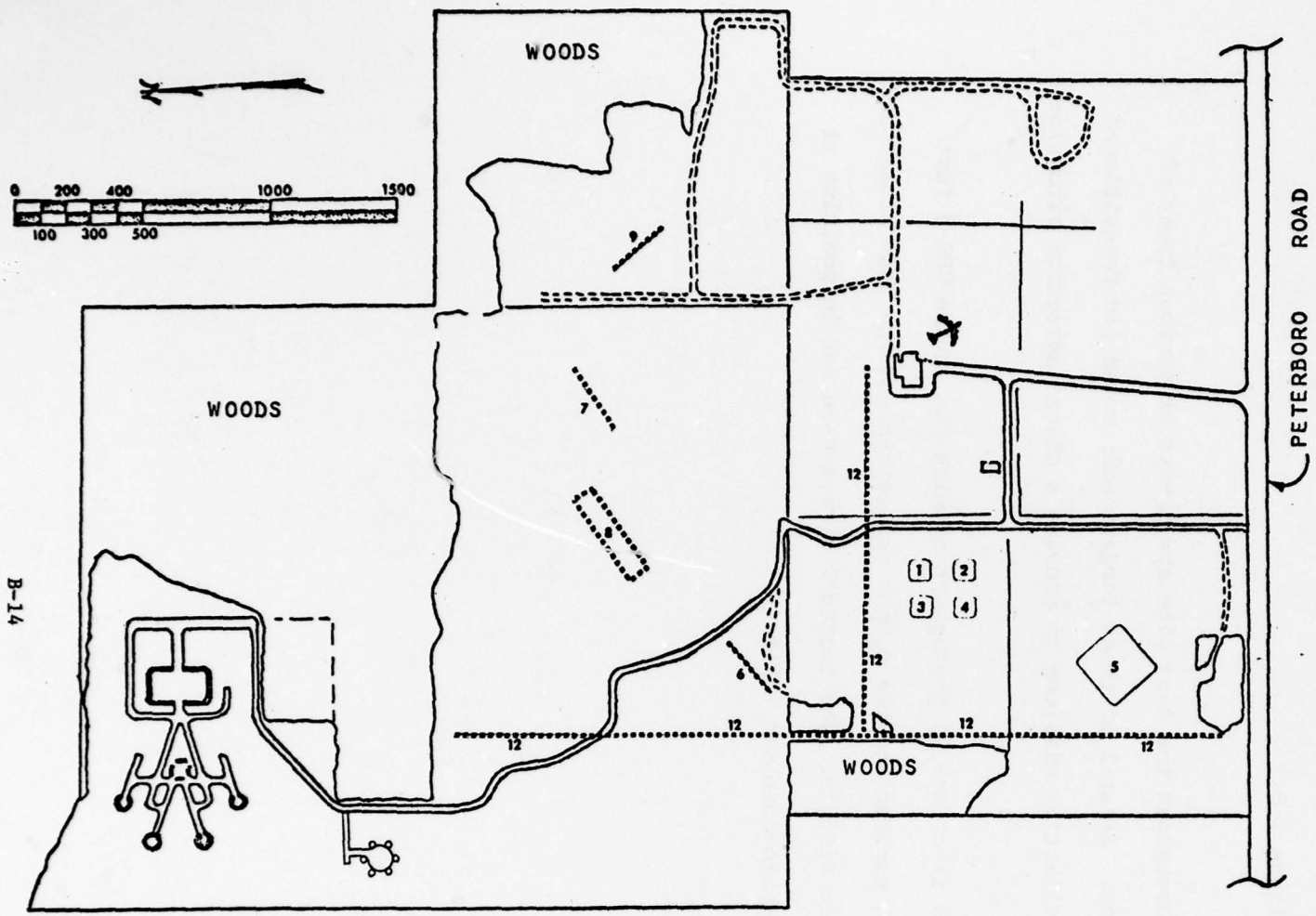
Figure 2-2 Topographic Relief of Test Site

2.1. TEST AREA

The test area is approximately 3,000' x 3,000' and is comprised of a number of specifically designed radar corner reflectors in 6 different array configurations. The corner reflectors along with four pads constructed of various background materials make up the engineering array. (See Figure 2-3.)

Located throughout the test site are arrays of various types of tactical targets. Several of these targets were moved and repositioned between data collection missions to provide a change detection situation.

Figure 2-4 is an aerial photograph showing the entire UPD-X test complex. Areas cleared for the corner reflectors and the four background pads are clearly visible. The tactical arrays were not in position at the time this photograph was taken.



UPD-X REFLECTOR ARRAYS FOR TESTS 1-C, 2-C AND 3-C.

STOCKBRIDGE TEST SITE

Figure 2-3 UPD-X Reflector Arrays for Tests 1-C, 2-C, and 3-C

Rome Research Corp.
Rome, N.Y.

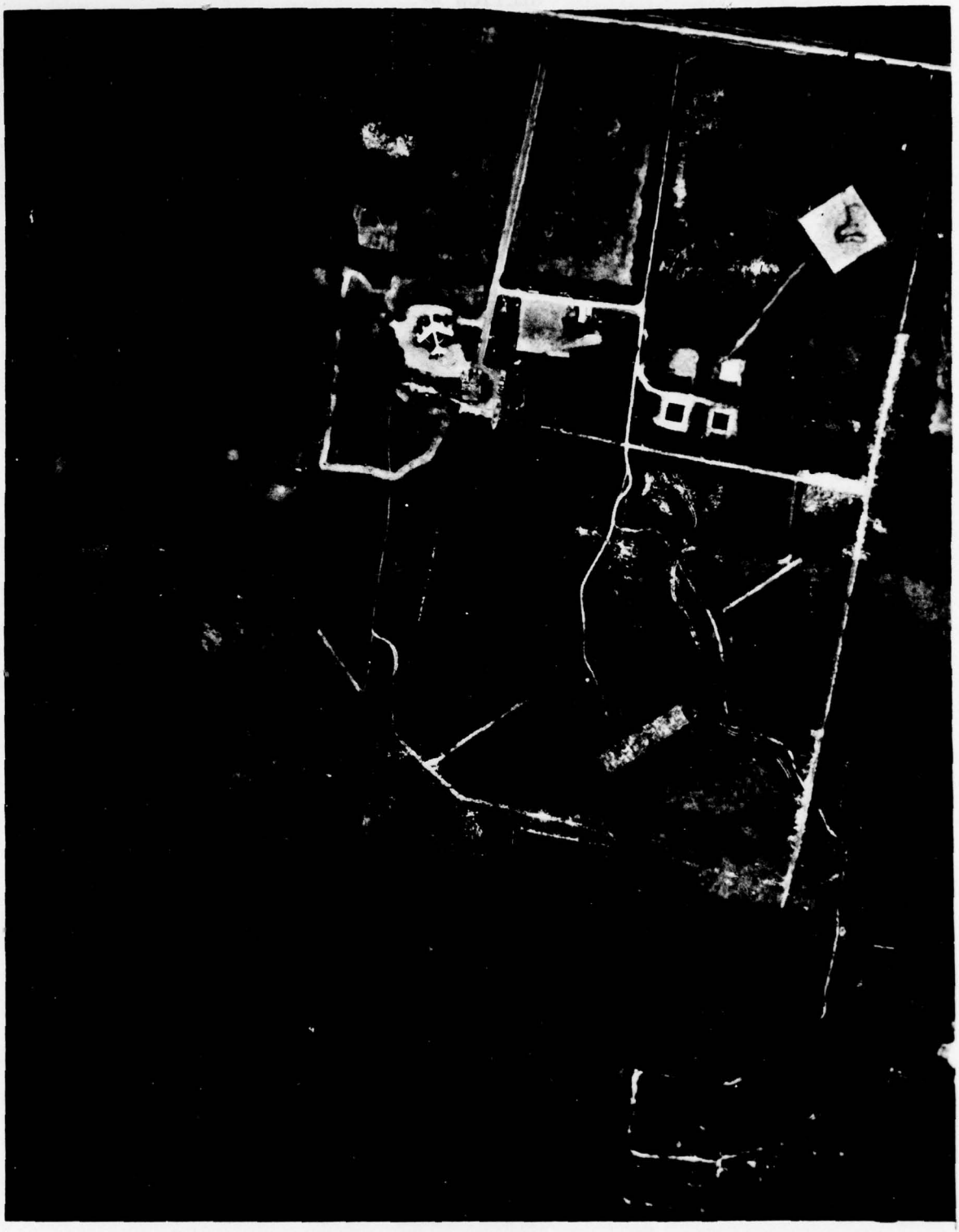


Figure 2-4. Aerial Photograph of UPD-X Test Complex.

SECTION 3

TEST SITE PREPARATION FOR SUMMER TESTS

Four major tasks were accomplished to prepare the Stockbridge Test Site for the UPD-X summer tests. The engineering array was surveyed, and radar corner reflectors were placed, oriented accurately, and leveled. All targets in the tactical array were surveyed and deployed. Final preparation consisted of site inspection and acceptance by RADC and ASD. Prior to and during periods of overflights, the test site was maintained and groomed in accordance with procedures outlined in the UPD-X Program Test Plan.

3.1. PREPARATION OF ENGINEERING ARRAY

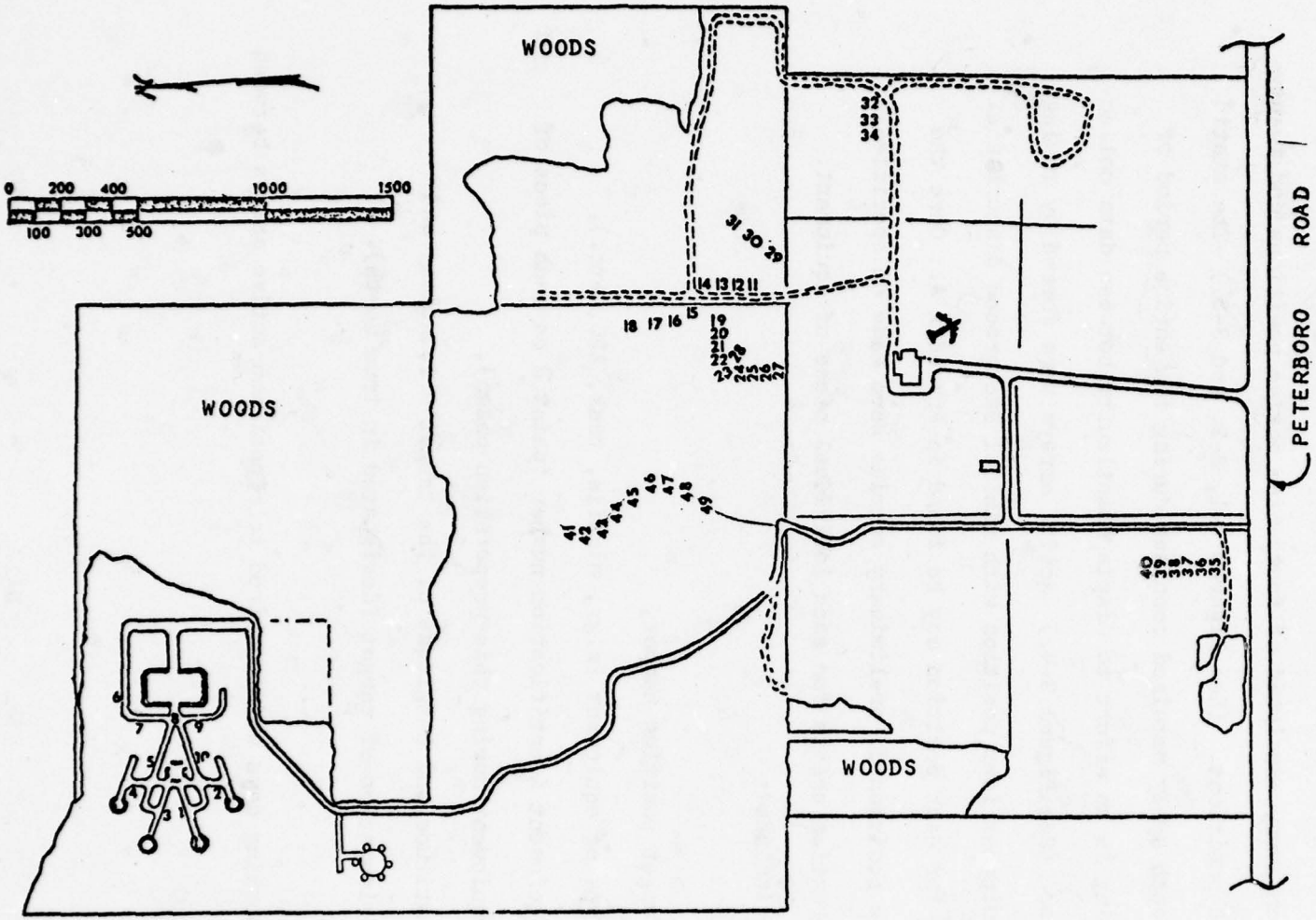
This task required each radar corner reflector to be surveyed in, leveled, and oriented true north. The surveying was done under a previous RADC contract with General Image Engineering Corporation, Provo, Utah. The actual emplacement, leveling, and orienting of reflectors was accomplished by RRC two weeks prior to the first summer test. Once the reflectors were emplaced, the immediate area surrounding each reflector was defoliated. Approximately ten feet of terrain around each reflector position was mowed to an overall grass length of 4 inches. All brush and trees directly to the north of each array were removed in accordance with the TEST SITE PLAN, UPD-X PHASE I PROGRAM.

3.2. PREPARATION OF THE TACTICAL ARRAY

Three predetermined configurations were employed as tactical target arrays. Each array consisted of forty-nine active positions and twenty-seven static positions. (See Figures 3-1, 3-2, and 3-3.) The static portion of each array remained constant during the entire period of summer testing in an effort to display continuity between data collection flights. (See Figure 3-4.) Active arrays were formed by towing tactical equipment into position with minimal background disturbance. Survey data for each position may be found in Appendix A. Once the targets were positioned, preliminary entries were made on specified target information sheets for each individual piece of equipment. Information included:

1. Target position number,
2. Type of equipment (e.g., missile, tank, APC, etc.),
3. Equipment identification number (painted on each piece of equipment during this preparation phase),
4. Latitude and Longitude of the target's location, and
5. Orientation of target (designated in true north).

Five working days were required to reposition active arrays between flights.

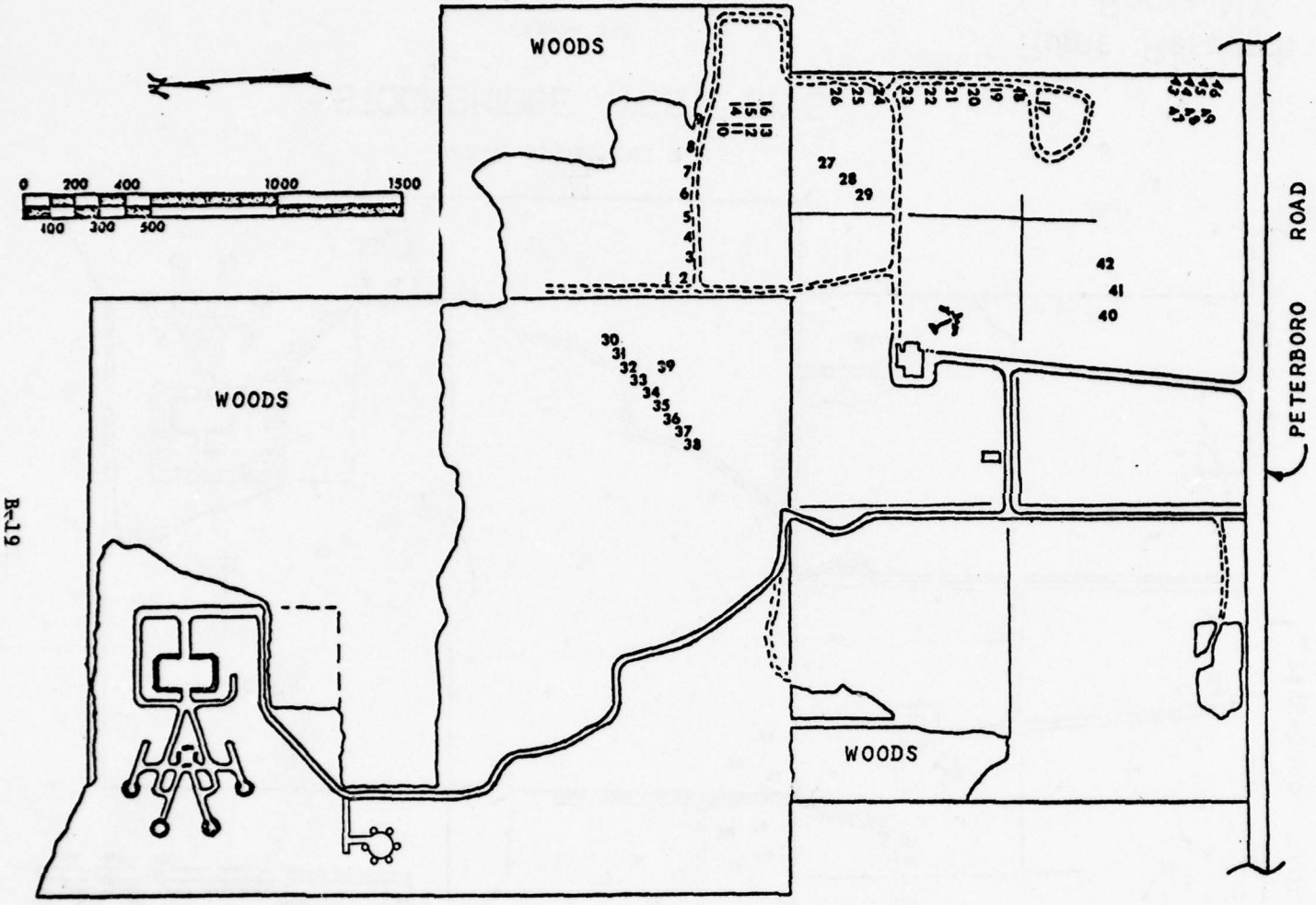


UPD-X SITUATION 1-C

STOCKBRIDGE TEST SITE

Figure 3-1 UPD-X Situation 1-C

Rome Research Corp.
Rome, N.Y.



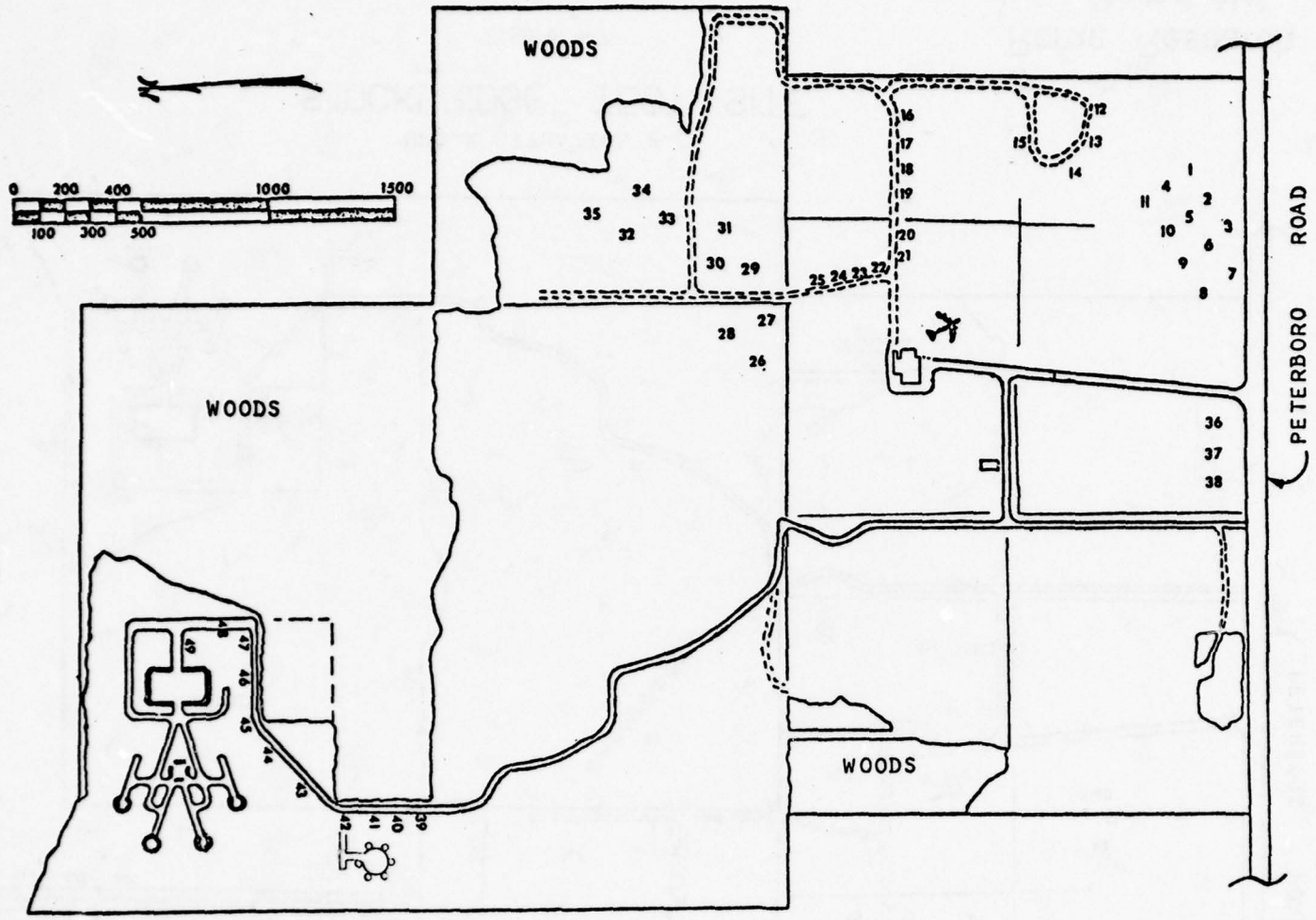
B-19

UPD-X SITUATION 2-C

STOCKBRIDGE TEST SITE

Figure 3-2

Rome Research Corp.
Rome. N.Y.



UPD-X SITUATION 3-C

STOCKBRIDGE TEST SITE

Figure 3-3

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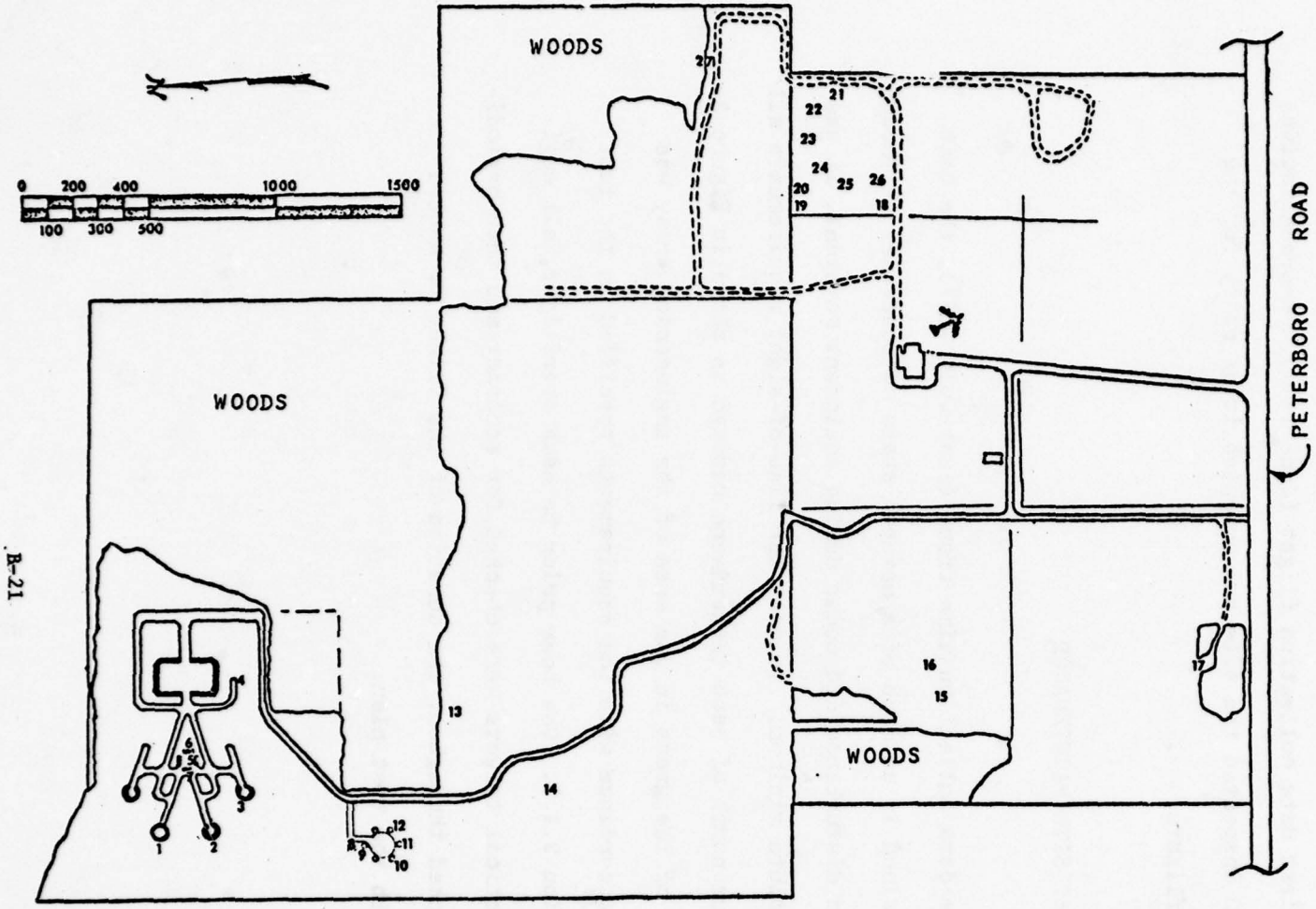
Rome, N.Y.



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UPD-X STATIC TARGETS FOR TESTS 1-C, 2-C, AND 3-C.

STOCKBRIDGE TEST SITE

Figure 3-4

Rome Research Corp.
Rome, N.Y.

3.3. FINAL SITE PREPARATION

All engineering and tactical arrays were in position two weeks prior to the first data collection flight (June 1977). Representatives of RADC and ASD inspected the site and accepted it as ready for the scheduled overflights.

3.4. TARGET SITE MAINTENANCE

During the data collection time frame (June-July 1977), the test site was maintained in as much of a natural state as possible. Although some background disturbance did occur during equipment movement, it was kept to an absolute minimum. To meet the line-of-sight requirements all obstructions due north of each target were removed as shown in Figure 3-5. The height of the grass in the area of the engineering array was maintained in accordance with the requirements specified in the test plan (see Section 3.1.). One hour prior to each overflight, all engineering and tactical targets were checked for accuracy and then periodically spot checked throughout the duration of the flight to assure consistency with the test plan.

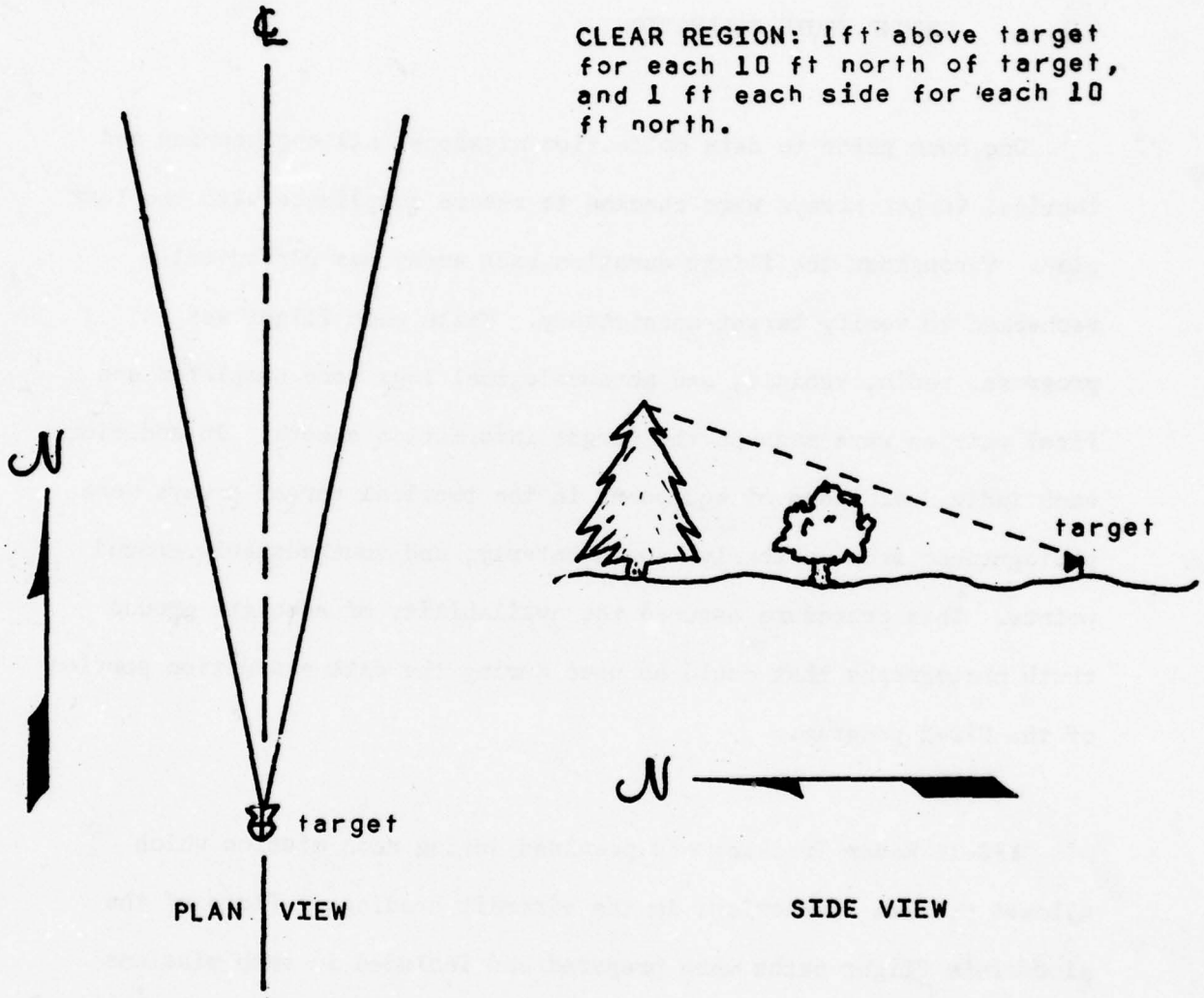


Figure 3-5 - LINE OF SIGHT
(Extracted from RADC TEST SITE PLAN)

SECTION 4

GROUND TRUTH COLLECTION FOR SUMMER TESTS

4.1. GROUND TRUTH COLLECTION

One hour prior to data collection missions, all engineering and tactical target arrays were checked to assure compliance with the test plan. Throughout the flight duration each array was periodically rechecked to verify target consistency. While each flight was in progress, radio, vehicle, and meteorological logs were completed and final entries were made on the target information sheets. In addition, each individual piece of equipment in the tactical target arrays were photographed from northerly, southwesterly, and southeasterly ground points. This procedure assured the availability of adequate ground truth photographs that could be used during the data evaluation portion of the UPD-X program.

FPS-16 Radar Tracking was provided during each mission which allowed precise corrections in the aircraft headings. Plots of the aircraft's flight paths were prepared and included in each missions' ground truth data packet.

4.2. GROUND TRUTH DATA PACKETS

All data collected during each mission was compiled into central packets referred to as the UPD-X Phase I Ground Truth Data Packets. Included in each packet are:

a. Radio log sheets

b. Vehicle log sheets

c. Meteorological data sheets

d. Specific target information sheets

e. FPS-16 radar plots

f. Tactical array site plans

g. Static target site plans

h. Documentation of the Controlled Change Array

i. Ground photographs (Ektachrome) of all tactical and static targets, and

j. Photo identification sheets

In accordance with the contractual work statement, all ground truth data packets were delivered to the RADC program engineer within a specified time period.

SECTION 5

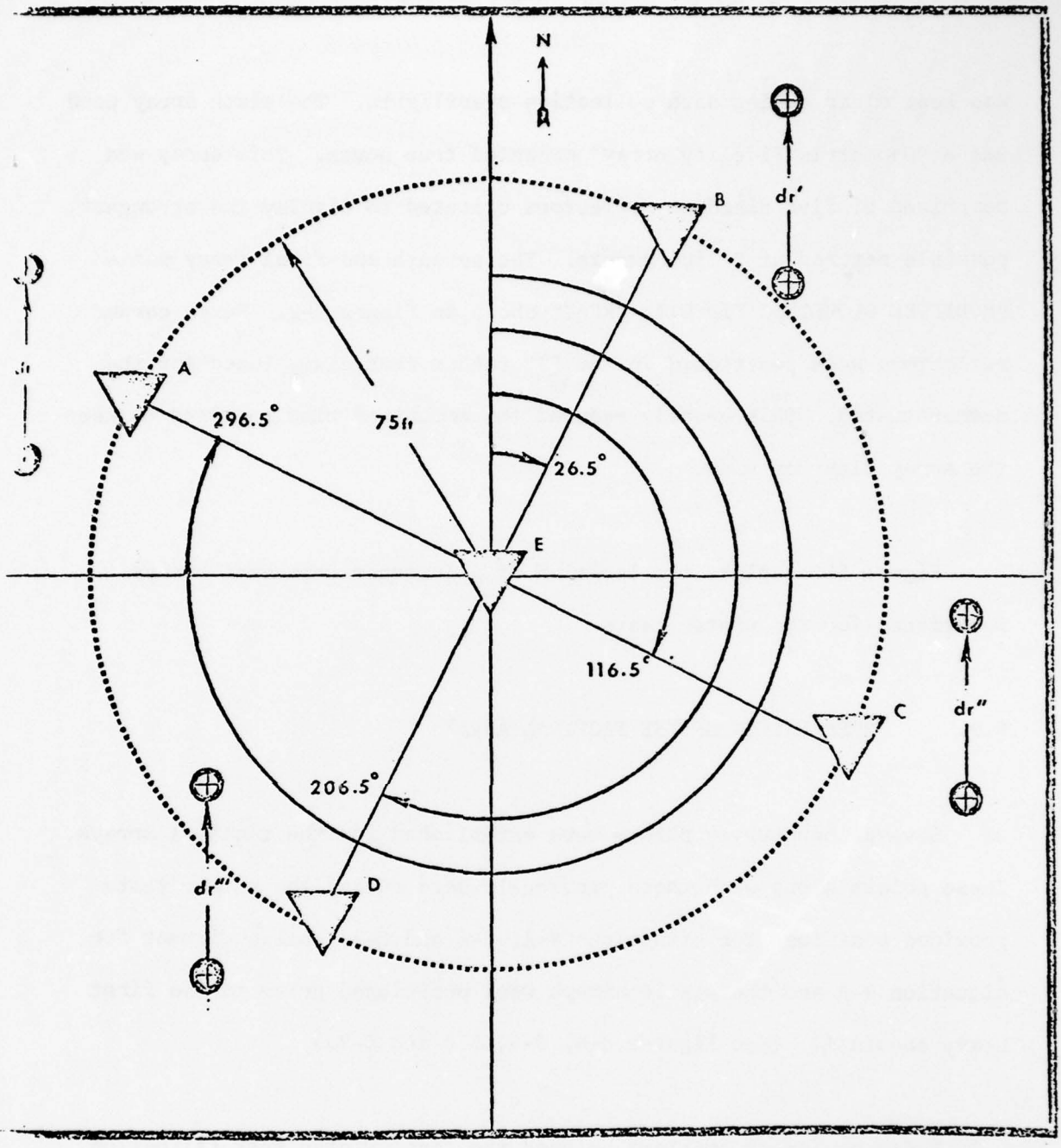
TEST SITE PREPARATION FOR WINTER TESTS

Test site preparation procedures for the UPD-X winter tests were similar to those employed during summer testing. Different radar corner reflector configurations were used and will be described in Subsection 5.1. New survey positions were required for the tactical arrays, and positioning of selected equipment was required prior to the first heavy snowfall. Inspection and acceptance of the site was required two weeks prior to the test flights. Requirements for site maintenance differed from the summer test phase requirements and will be addressed in Subsection 5.4.

The UPD-X PHASE I - WINTER TEST PLAN provided by RADC/IRRE provided guidance to the team preparing the site for winter tests.

5.1. PREPARATION OF ENGINEERING ARRAY

Seven radar corner reflector arrays were randomly positioned throughout the site for the winter phase of UPD-X testing. Five "Interaction Comparison Arrays," each geometrically identical, were "surveyed-in" and positioned. Figure 5-1 graphically illustrates the configuration of these arrays. Four reflectors in each of these arrays were emplaced prior to heavy snowfall in an effort to allow them to be completely covered with snow. A fifth reflector was placed on top of the snow and



NOTES: Reflectors A, B, C, and D are all covered by natural snow.
Reflector E is mounted above the snow surface.
The distances dr, dr', dr'', and dr''' are determined by the local snow depth (dp) using the following formula; dr = 12dp.

Figure 5-1 - Interaction Comparison Array (one of five groups)

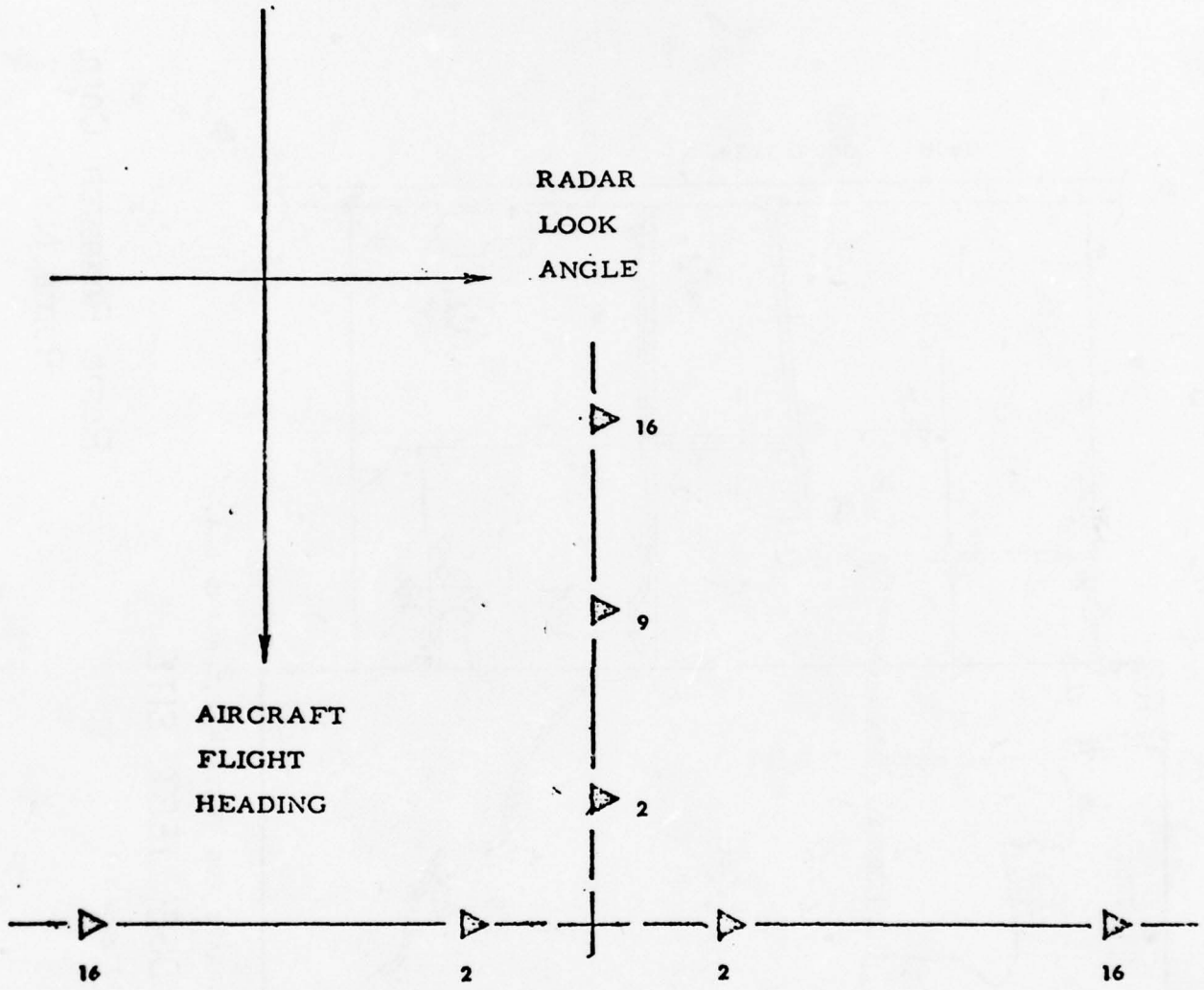
was kept clear during data collection overflights. The sixth array used was a "Geometric Fidelity Array" oriented true north. This array was comprised of five dihedral reflectors oriented to display the strongest possible returns at 2° increments. The seventh and final array was a "MODIFIED GEOMETRIC FIDELITY ARRAY" shown in Figure 5-2. Seven corner reflectors were positioned in the "T" rather than sixty (used for the summer tests). This greatly reduced the amount of time required to keep the array clear of snow.

Figure 5-3 depicts the location of all corner reflector arrays positioned for the winter tests.

5.2. PREPARATION OF THE TACTICAL ARRAY

Several new survey points were established for the tactical arrays. These points along with those previously used during the summer tests provided positions for situations 4-A, 5-A and 6-A. All equipment for situation 4-A and the static arrays were positioned prior to the first heavy snowfall. (See Figures 5-4, 5-5, 5-6 and 5-7.)

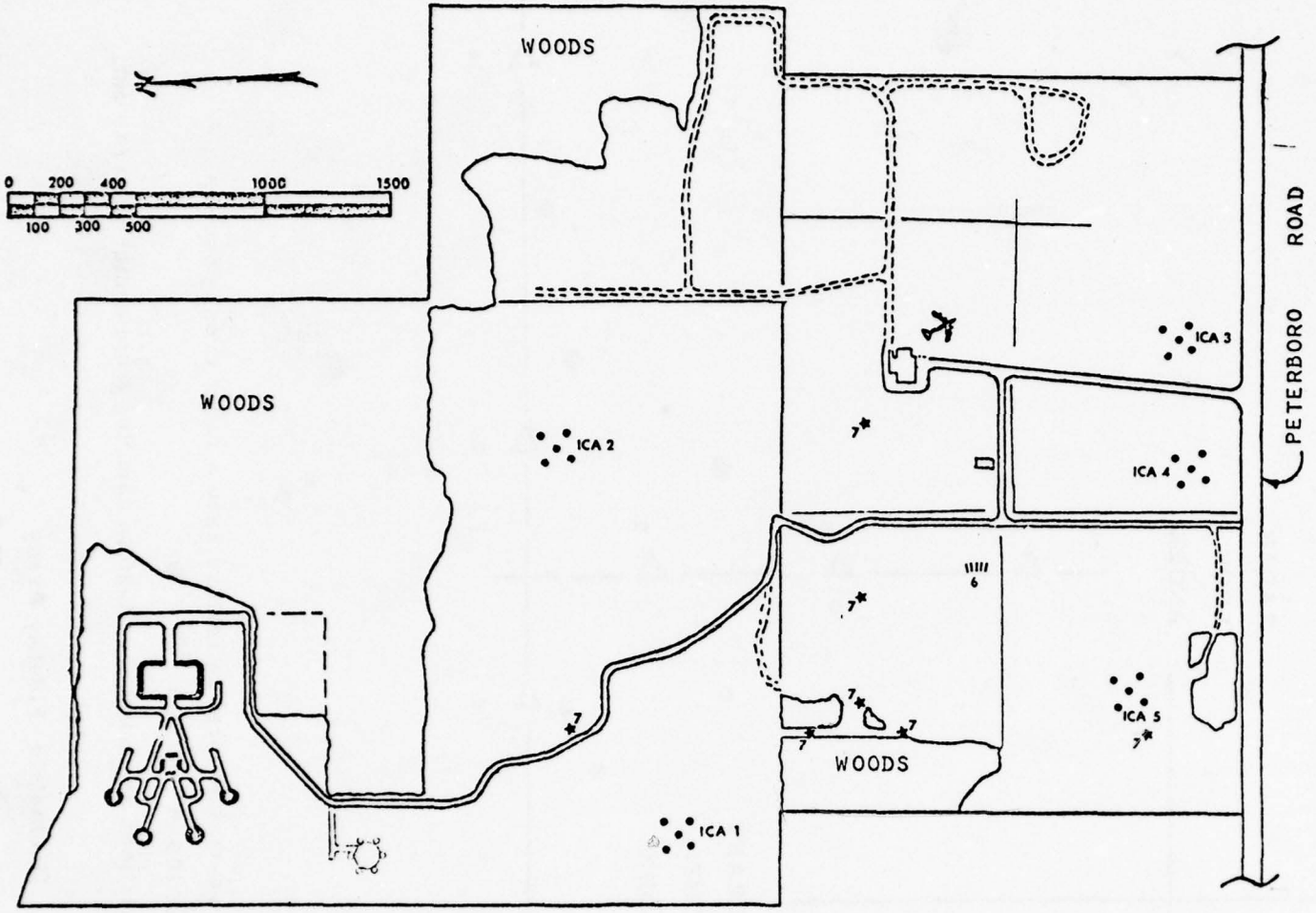
Radar equipment problems delayed the first winter test (situation 4-A) until March 21. Due to rapidly deteriorating snow conditions at this time, the second winter test was scheduled for April 4, to insure at least a partial snow cover. Because of the quick turnaround time between tests and the patchy snow conditions, the tactical array for the second test (situation 5-A) was modified (see Figure 5-8). Situation 6-A was not flown.



NOTES: All seven trihedral reflectors have a radar cross-section of 100 m^2.

Posistions are numbered 1-20 in each leg from center of array out.

Figure 5-2 - Geometric Fidelity Array

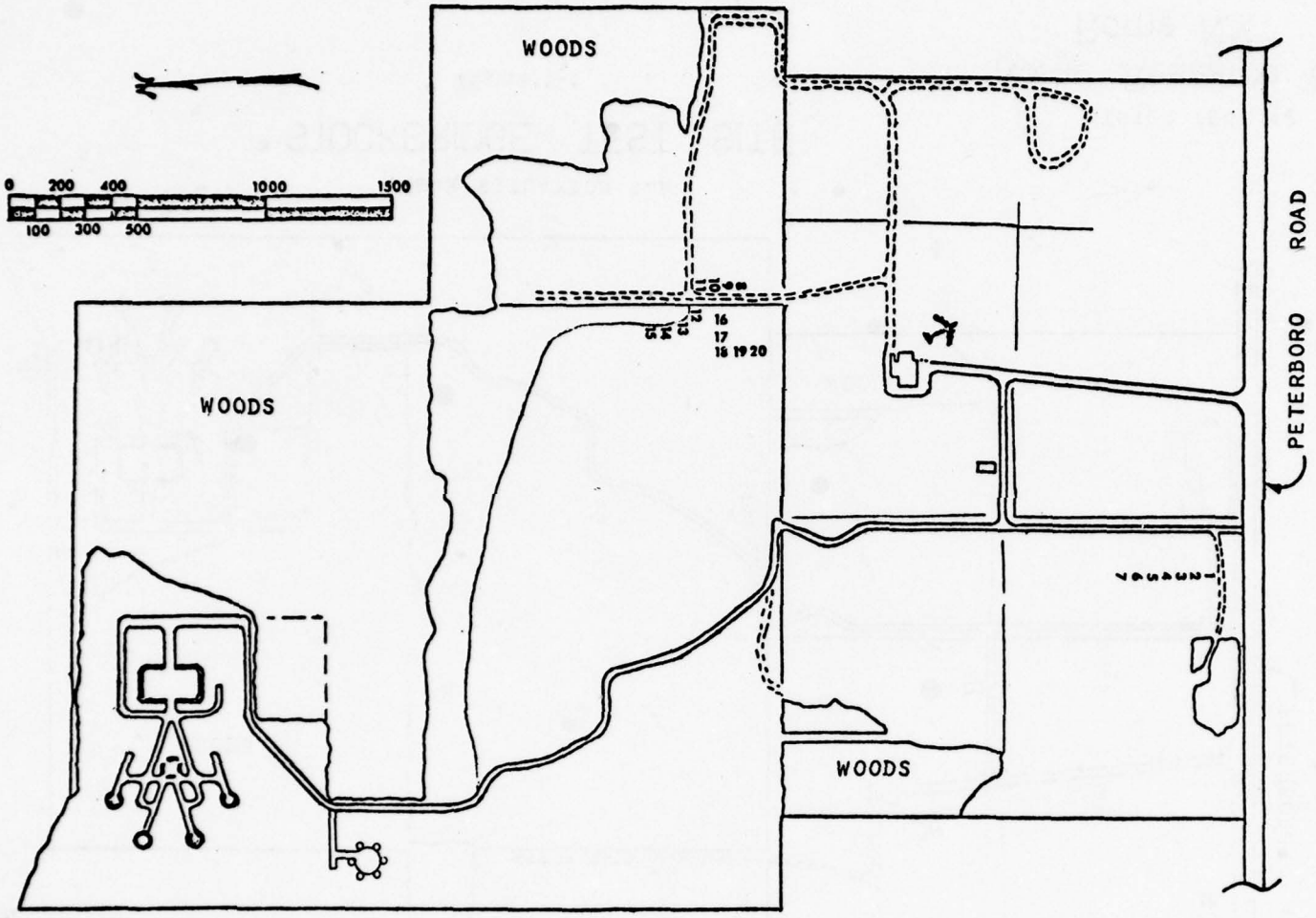


UPD-X REFLECTOR ARRAYS FOR TESTS 4-A,5-A AND 6-A.

STOCKBRIDGE TEST SITE

Figure 5-3

Rome Research Corp.
Rome, N.Y



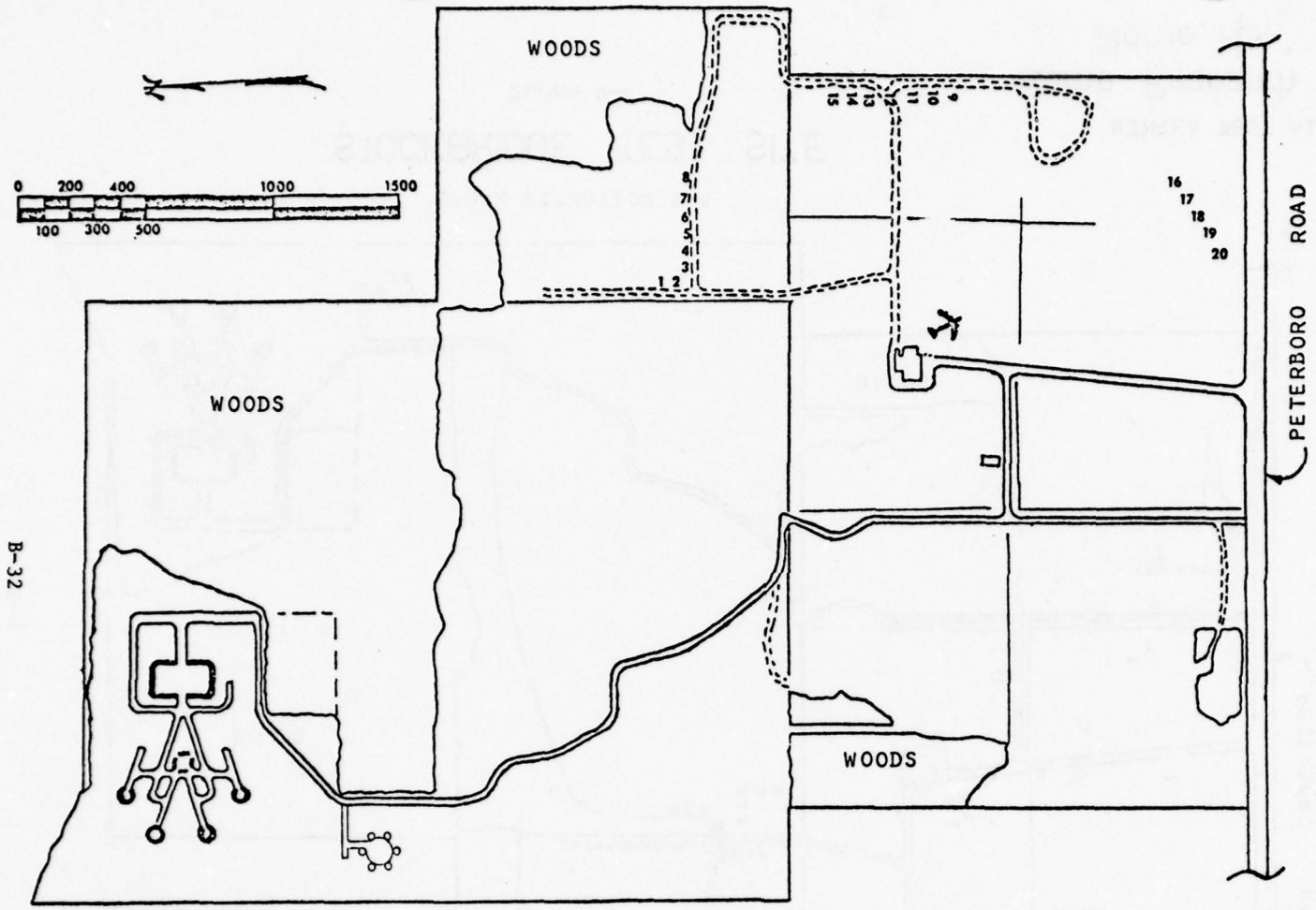
UPD-X SITUATION 4-A

STOCKBRIDGE TEST SITE

Figure 5-4

WINTER TEST #1

Rome Research Corp.
Rome, N.Y.



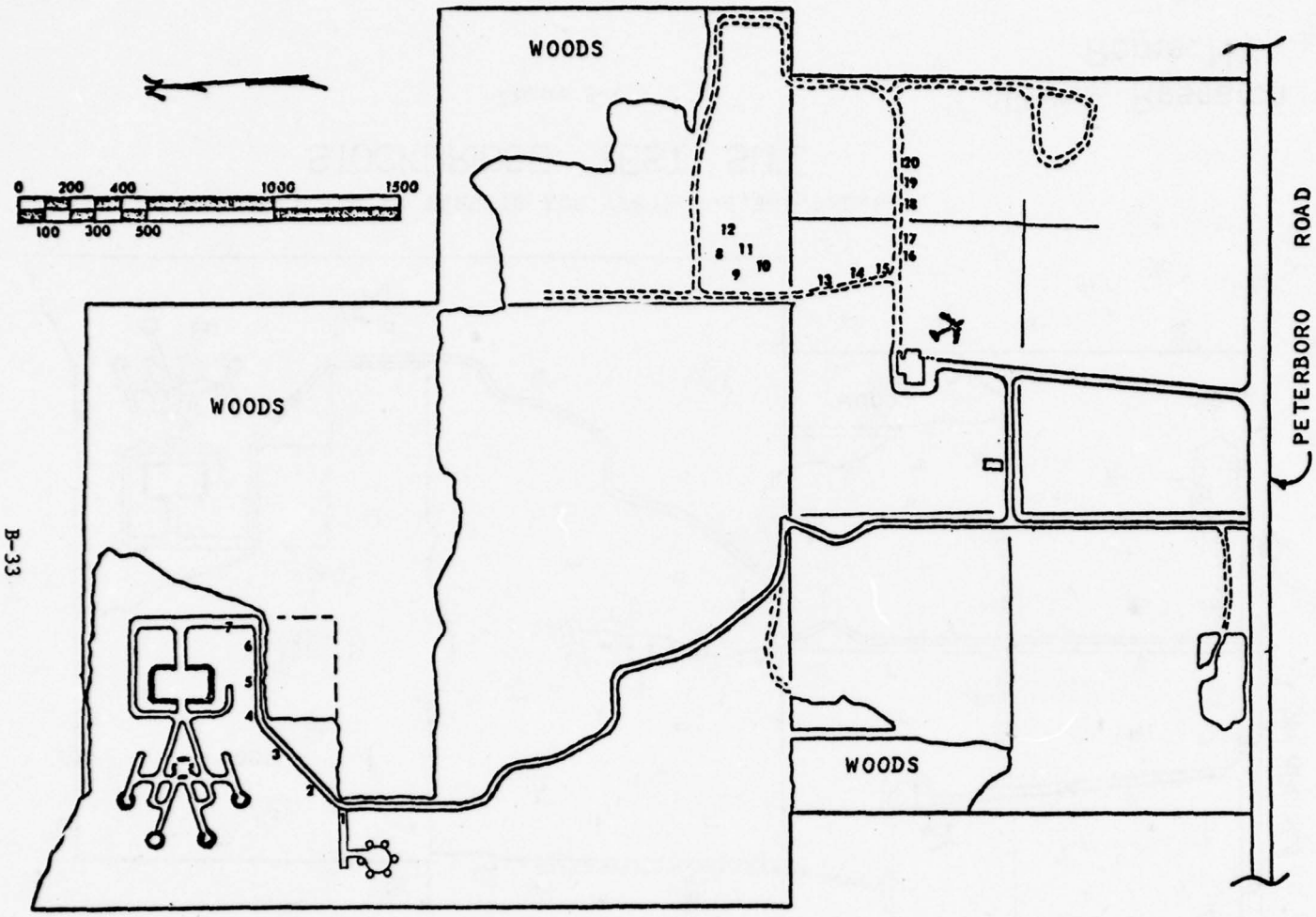
UPD-X SITUATION 5-A

STOCKBRIDGE TEST SITE

Figure 5-5

WINTER TEST #2

Rome Research Corp.
Rome, N.Y.



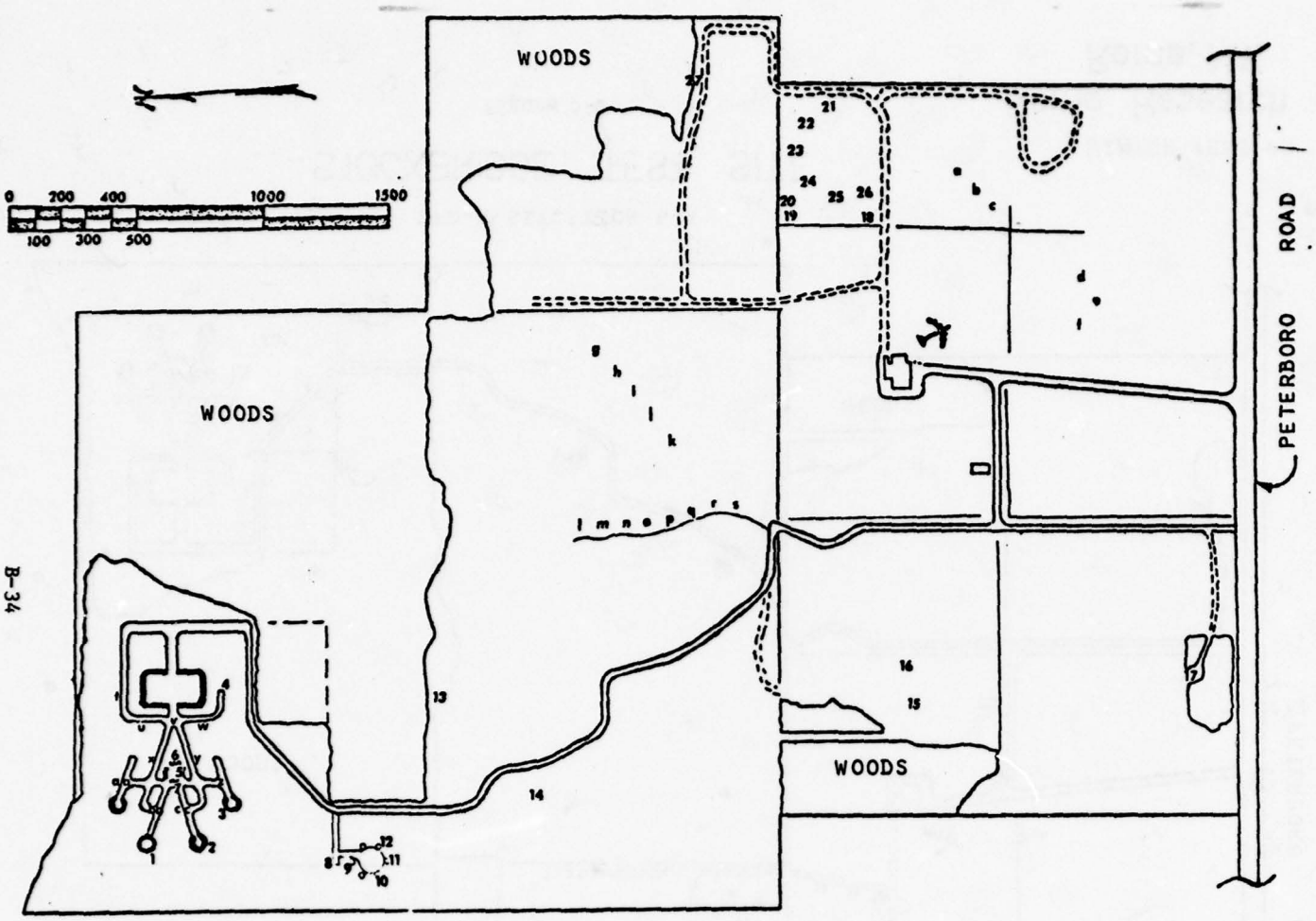
UPD-X SITUATION 6-A

STOCKBRIDGE TEST SITE

Figure 5-6

WINTER TEST #3

Rome Research Corp.
Rome, N.Y.



UPD-X STATIC TARGETS FOR TESTS 4-A,5-A,AND 6-A.

STOCKBRIDGE TEST SITE

Figure 5-7

Rome Research Corp.
Rome, N.Y.

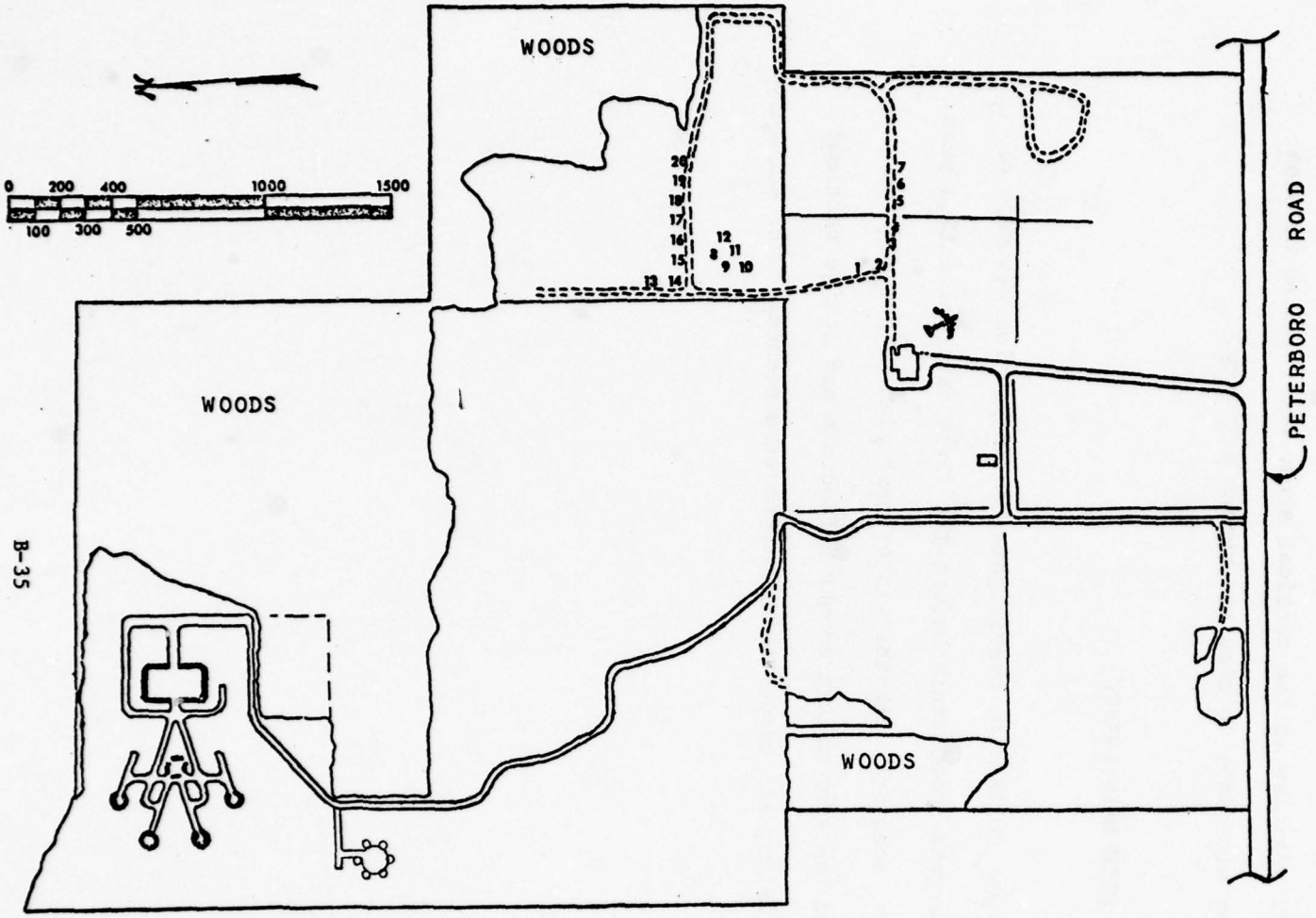


Figure 5-8
Situation 5-A As Flown on April 4, 1978

Rome Research Corp.
Rome, N.Y.

5.3. FINAL SITE PREPARATION

One day prior to each data collection mission, the "Dihedral Reflector Array," the "Modified Geometric Fidelity Array" and the center reflectors of the "Interaction Comparison Arrays" were emplaced and oriented. All vehicles in the tactical array were cleared of snow and vehicle tracks were made to simulate recent activity.

5.4. TARGET SITE MAINTENANCE

On days of data collection overflights, an inspection was made of all arrays and targets immediately before the first data collection pass was made to insure accuracy with the winter test plan. Snow and ice were removed from the appropriate corner reflectors and active tactical targets. In addition, all target orientations were rechecked for accuracy.

SECTION 6

GROUND TRUTH COLLECTION FOR WINTER TESTS

6.1. GROUND TRUTH COLLECTION

During the data collection flights, all logs were updated on an hourly basis. In addition to the information supplied for the summer tests, the relative humidity and ambient light intensity were included on the meteorological data sheet. Regular inspections were made of the arrays to assure their conformity to the test plan.

6.2. GROUND TRUTH DATA PACKETS

Contained in each of the Ground Truth Data Packets are the following items:

a. Radio log sheets
b. Vehicle log sheets
c. Meteorological Data Sheets
d. Specific target information sheets
e. FPS-16 radar plots
f. Tactical array site plans
g. Static target site plans
h. Ground photographs (Ektachrome) of all tactical and static targets and photo identification sheets
i. Report sheets prepared and provided by the weather squadron

In accordance with the contractual work statement, all ground truth data packets were delivered to the RADC program engineer within a specified time period.

SECTION 7

GEODETIC INFORMATION

This section contains the Geographic Locations (Latitude and Longitude) and Universal Transverse Mercator (UTM) Grid coordinates for all control points at the Stockbridge Test Site.

Table 7-1 contains the Geographic Locations of survey markers located at each of the normal tactical arrays. Table 7-2 contains the UTM coordinates for these markers. These points were used as control for determination of UTM location for each tactical vehicle for summer and winter UPD-X flights. UTM coordinates for each of these vehicles are included in Appendix B. Figure 7-1 depicts the relative locations of control points.

The summer UPD-X program utilized nine array pads as discussed in Section 2.1. The Geographic Locations and UTM coordinates for these pads are shown in Table 7-3. The winter UPD-X program will utilize five Interaction Comparison Arrays as discussed in Section 5.1. The UTM coordinates for these arrays may be found in Appendix B.

7.1. METHOD FOR CONVERTING FIELD SURVEY DATA TO GEODETIC COORDINATES

Procedures

Conversion of field survey data to geodetic coordinates was done on a Wang 700 B Program Package. A two part program was used entitled

Table 7-1

Geographic Locations and Elevations
Stockbridge Test Site Control Points

Point	Latitude North	Longitude West	Elevation* Feet
RADC 1956	43° 01' 56".15[illegible]	75° 38' 36".450	1273.43
10-A-1 SAM	43° 02' 22".370	75° 39' 22".951	1249.65
10-A-2 AAA	43° 02' 14".598	75° 39' 26".116	1245.41
10-A-3 Mortar	43° 02' 07".802	75° 39' 22".454	1263.85
10-A-4 N.E.	43° 02' 02".727	75° 39' 17".745	1273.16
10-A-4 S.E.	43° 01' 59".767	75° 39' 17".526	1266.52
10-A-4 S.W.	43° 01' 59".553	75° 39' 22".903	1256.17
10-A-4 N.W.	43° 02' 02".513	75° 39' 23".122	1260.49
10-A-5 Artillery	43° 01' 55".038	75° 39' 15".041	1265.10
10-A-6 Convoy	43° 01' 46".811	75° 39' 07".257	1275.44
10-A-7 Supply	43° 01' 51".426	75° 38' 45".844	1262.07
10-A-8 Asslt Engr	43° 01' 58".324	75° 38' 52".448	1271.91
10-A-9 Command Post	43° 02' 04".106	75° 38' 46".029	1279.56
10-A-10 SSM	43° 02' 10".852	75° 38' 57".181	1276.91
10-A-11 Spare	43° 02' 00".424	75° 38' 58".043	1269.81
10-A-12 Armor	43° 02' 11".751	75° 39' 19".484	1265.06
10-A-12 Alternate	43° 02' 11".387	75° 39' 06".203	1283.48
Azimuth Monument	43° 02' 02".477	75° 39' 07".684	1282.03
10-A-13 VSTOL	43° 01' 43".658	75° 39' 15".041	1249.62

Defensive Position

*NOTE: All elevation are referenced to the top of the wooden stakes which mark the points.

DATOM: North American Datum 1927
Sea Level Datum 1929

ACCURACY: ± 0.5 feet from local third order horizontal control

Table 7-2

Universal Transverse Mercator (UTM) Grid Coordinates: Zone 18,
Central Meridian 75° West Longitude
Stockbridge Test Site Control Points

Point	Northings Meters	Eastings Meters	Elevation Meters
RADC 1956	4764331.684	446966.716	388.123
10-A-1 SAM	4765200.459	446532.666	380.89
10-A-2 AAA	4764961.278	446459.174	379.60
10-A-3 Mortar	4764750.996	446540.399	385.222
10-A-4 NE (Defensive Position)	4764593.616	446645.738	388.060
10-A-4 SE (Defensive Position)	4764502.271	446649.982	386.036
10-A-4 SW (Defensive Position)	4764496.621	446528.250	382.881
10-A-4 NW (Defensive Position)	4764587.965	446524.008	384.198
10-A-5 Artillery	4764355.960	446705.080	385.603
10-A-6 Convoy	4764100.812	446879.263	388.755
10-A-7 Supply	4764239.425	447364.957	384.680
10-A-8 Asslt Engr	4764453.355	447217.148	387.679
10-A-9 Command Post	4764630.593	447363.781	390.011
10-A-10 SSM	4764840.631	447113.028	389.203
10-A-11 Spare	4764519.112	447091.033	387.039
10-A-12 Armor	4764872.285	446608.558	385.591
10-A-12 Alternate	4764858.717	446909.001	391.205
Azimuth Monument	4764584.080	446873.352	390.743
10-A-13 VSTOL	4764004.920	446702.340	380.866

ACCURACY: ± 0.15 meters considering both the error in the geographic position and the conversion to UTM.

Table 7-3

Geodetic To UTM Conversion Stockbridge Array Pads

Station	Latitude	Longitude	Northing	Easting
RADC-1 NGS 1976	43 1 54.31700N	75 39 3.47200W	4764331.684	446966.716
TRI STA 5 RADC 56	43 1 56.15519N	75 38 56.48949W	4764387.163	447125.170
EAST BOUNDARY	43 1 57.04752N	75 39 .39102W	4764415.372	447037.091
SOUTHWEST BOUNDARY	43 1 42.00545N	75 39 20.90217W	4763954.984	446569.299
ARRAY PAD 5	43 1 47.83807N	75 39 16.72725W	4764134.163	446665.187
ARRAY PAD 2	43 1 53.76028N	75 39 10.29297W	4764315.710	446812.222
ARRAY PAD 4	43 1 53.75213N	75 39 12.73769W	4764315.889	446756.895
ARRAY PAD 3	43 1 55.56921N	75 39 12.47611W	4764371.894	446763.251
ARRAY PAD 1	43 1 55.56525N	75 39 10.30009W	4764372.006	446812.498
ARRAY PAD 6	43 2 1.14996N	75 39 16.31009W	4764544.718	446677.829
ARRAY PAD 8	43 2 7.59377N	75 39 11.96193W	4764742.722	446777.773
ARRAY PAD 7	43 2 8.22348N	75 39 4.11789W	4764760.767	446955.426
NORTHEAST BOUNDARY	43 2 11.83606N	75 39 .39164W	4764871.550	447040.610
AUX STA A	43 2 4.25096N	75 39 20.47932W	4764641.109	446584.228
WEST BOUNDARY	43 1 57.04466N	75 39 20.58747W	4764418.838	446580.045
AUX STA B	43 2 4.08221N	75 39 20.58977W	4764635.923	446581.688
NORTHWEST BOUNDARY	43 2 11.85863N	75 39 20.59198W	4764875.801	446583.512
ARRAY PAD 9	43 2 7.02198N	75 38 56.25809W	4764722.327	447132.998
AUX STA C	43 1 56.33199N	75 38 56.62699W	4764392.641	447122.101

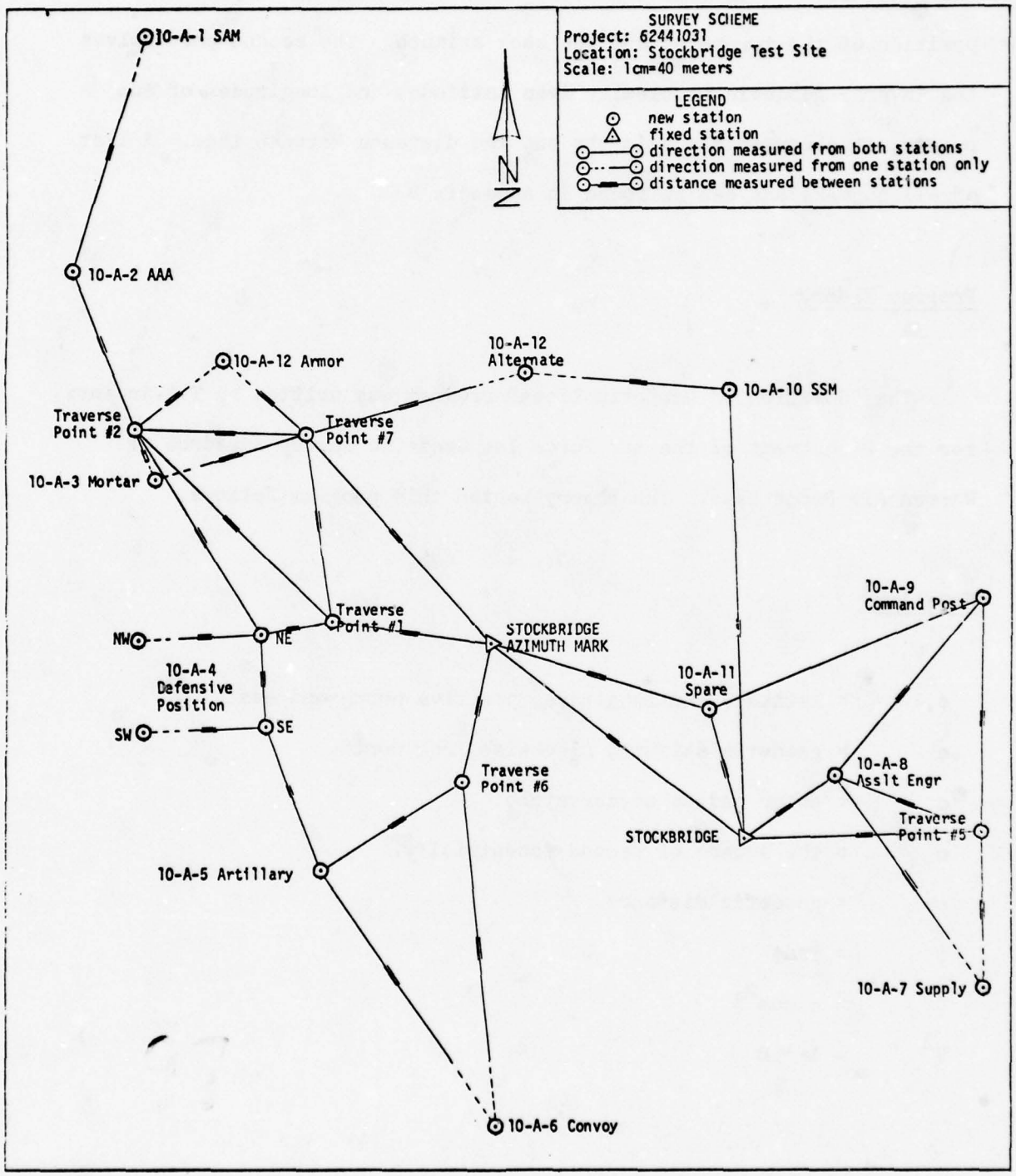


Figure 7-1 Relative Position of Control Points

"Solution of Geodetic Lines." The first part of this program solves the direct geodetic problem. Given latitude and longitude of the standpoint and geodetic azimuth and distance to the forepoint, it computes the position of the forepoint and the back azimuth. The second part solves the inverse geodetic problem. Given latitudes and longitudes of two points, it computes the azimuths and the distance between them. A list of all conversions can be found in Appendix B.

Program Theory

The "Solution of Geodetic Lines" program was written by T. Vincenty for the Department of the Air Force 1st Geodetic Survey Squadron at Warren Air Force Base. The theory behind this program follows.

Notation

ϕ,λ = latitude and longitude, positive north and east.

α = geodetic azimuth, clockwise from north.

c = polar radius of curvature.

ε = the square of second eccentricity.

s = geodetic distance.

T = $\tan\phi$

D = $\varepsilon \cos^2\phi$

V^2 = $1 + D$

Part 1

This is an iterative method. The equations are approximations of the long line formula by H.F. Rainsford (Empire Survey Review 70, 1949). Fourth and higher order terms have been omitted and elliptic terms have been omitted from third-order terms.

The number of sections of the line is determined by

$$n = s/15000 + 1, \text{ truncated to integer.}$$

Each section is solved by the following equations in which all arguments are for the standpoint.

$$\theta = \frac{s}{nc}$$

$$\Delta\phi = V^3\theta(\cos\alpha - (1/12)\theta(3T(\sin^2\alpha(2 - 5D) + 6D) + 2\theta \cos\alpha \sin^2\alpha(1 + 3T^2)))$$

$$\Delta\lambda = V\theta \sec\phi \sin\alpha(1 + (1/6)\theta(3T \cos\alpha(2 + D) + 2\theta(1 + 3T^2 - \sin^2\alpha(1 + 4T^2))))$$

$$\Delta\alpha = V\theta \sin\alpha(T + (1/12)\theta(3\cos\alpha(2 + 4T^2 + 3D) + 2\theta T(5 + 6T^2 - 2\sin^2\alpha(3 + 4T^2))))$$

Part 2

The inverse formula is that given by H.F. Rainsford in Appendix I, Vol. 2, Clark's "Plane and Geodetic Surveying for Engineers," 5th Edition. All arguments are for midlatitude.

$$a_1 = (1/8)D(1 - T^2)$$

$$b_1 = -(1/24)(2 + 3T^2 + 2D)$$

$$a_2 = (1/24)(1 - D(1 + 9T^2))$$

$$b_2 = -(1/24)T^2$$

$$a_3 = (1/24)(3 + 2D)$$

$$b_3 = (1/12)(1 + D)$$

$$\Delta\phi = \phi_2 - \phi_1$$

$$\Delta L = (\lambda_2 - \lambda_1)\cos\phi$$

$$x = (\Delta\phi/V^3)(1 + a_1\Delta\phi^2 + b_1\Delta L^2)$$

$$y = (\Delta L/V)(1 + a_2\Delta\phi^2 + b_2\Delta L^2)$$

$$z = T\Delta L\,(1 + a_3\Delta\phi^2 + b_3\Delta L^2)$$

$$r^2 = x^2 + y^2$$

$$s = cr$$

$$\tan A = y/x$$

$$a_{12} = A - (1/2)z$$

$$a_{21} = A + (1/2)z \pm \pi$$

SECTION 8

CONCLUSIONS AND RECOMMENDATIONS

8.1. CONCLUSIONS

Rome Research Corporation is confident that the Stockbridge Test Site was accurately configured for the UPD-X Summer and Winter data collection flights. All work was performed in accordance with the test plans provided by RADC/IRRE.

Stockbridge offered a site with the types of background terrain and climatology required by this type of test. Its location in close proximity to Griffiss Air Force Base minimizes coordination, administration, logistics and supply problems. In addition, the assistance provided by RADC/WE in collecting and recording meteorological data was of great value to the program.

Much experience was gained from the UPD-X tests that can be employed during future efforts.

8.2. RECOMMENDATIONS

Rome Research Corporation offers the following recommendations for improving test site support for future data collection programs:

1. More operational tactical targets for ease of target relocation.

2. Better site control, especially in winter and rainy weather to reduce or eliminate snowmobile and vehicular traffic and vandalism caused by unauthorized personnel gaining access to the site from unfenced areas.

3. Should another test area for UPD-X or similar radar programs be required, more care should be taken in original layout and construction of array pads. Examples:

   a. "T" array - more consideration should be given to proper grading techniques to eliminate knolls which block out some reflector returns, and to eliminate low areas of poor drainage which creates mud and increases difficulty of preparation and maintenance of this array. Also, array should be oriented in relation to either true or magnetic north to maximize reflector return relative to flight path. Present array is neither.

   b. "240^2 pad" dihedral array - more care should be given to preparation of a level surface prior to array implementation. Present pad is located on a slope which caused erosion problems after defoliation. Also elimination of the hedge line north of this array would probably increase reflector return on some flight paths.

4. Better design of reflector bases. Present plastic reflector bases are totally inadequate for winter testing as the cold

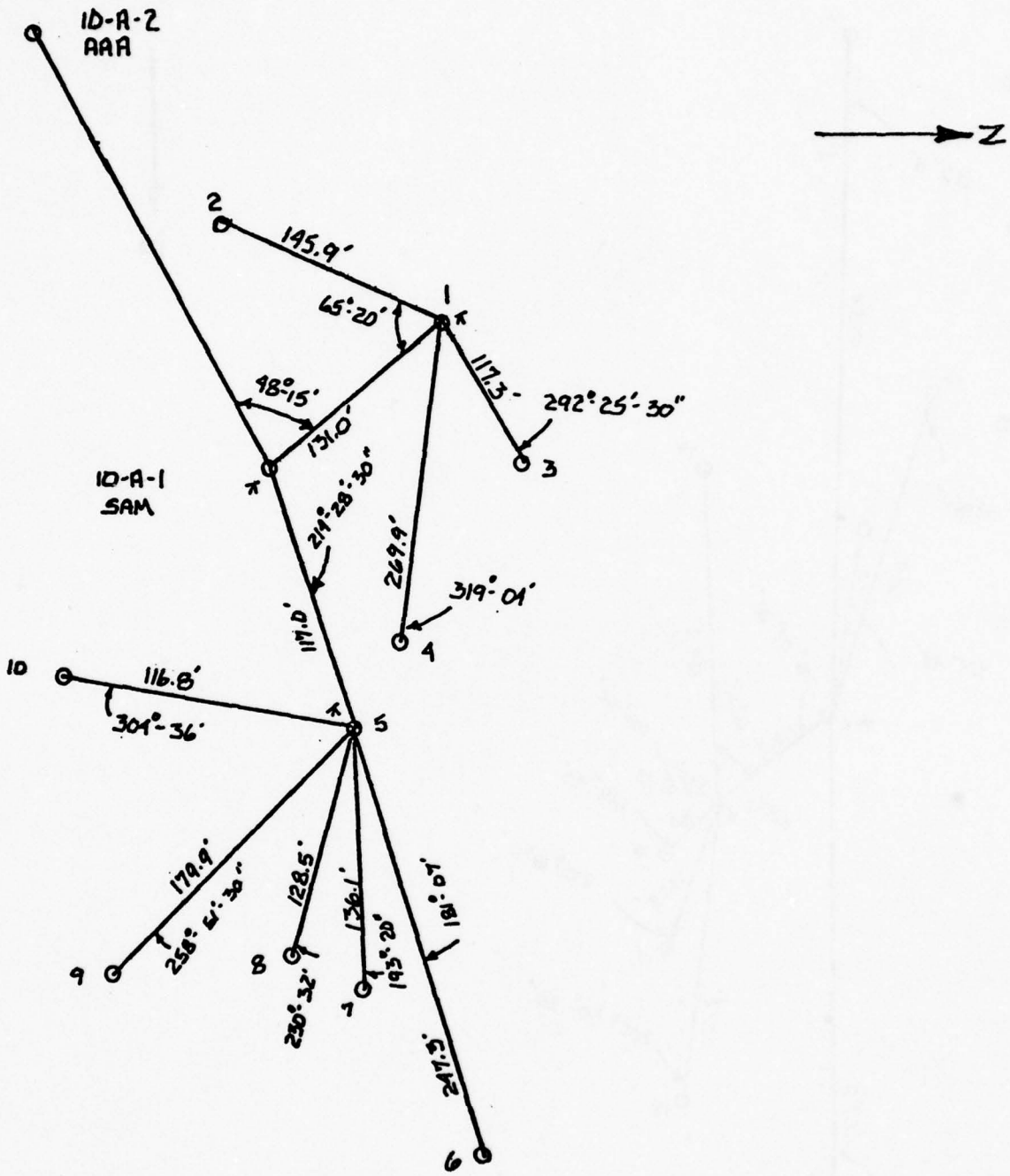
makes the plastic very brittle and the bases break easily. Also, the design of the present bases restricts the accuracy of levelling and orientation of reflectors due to internal "slope" and spacing of retaining pins. An all metal calibrated base as used by some other programs would be a major improvement.

APPENDIX A

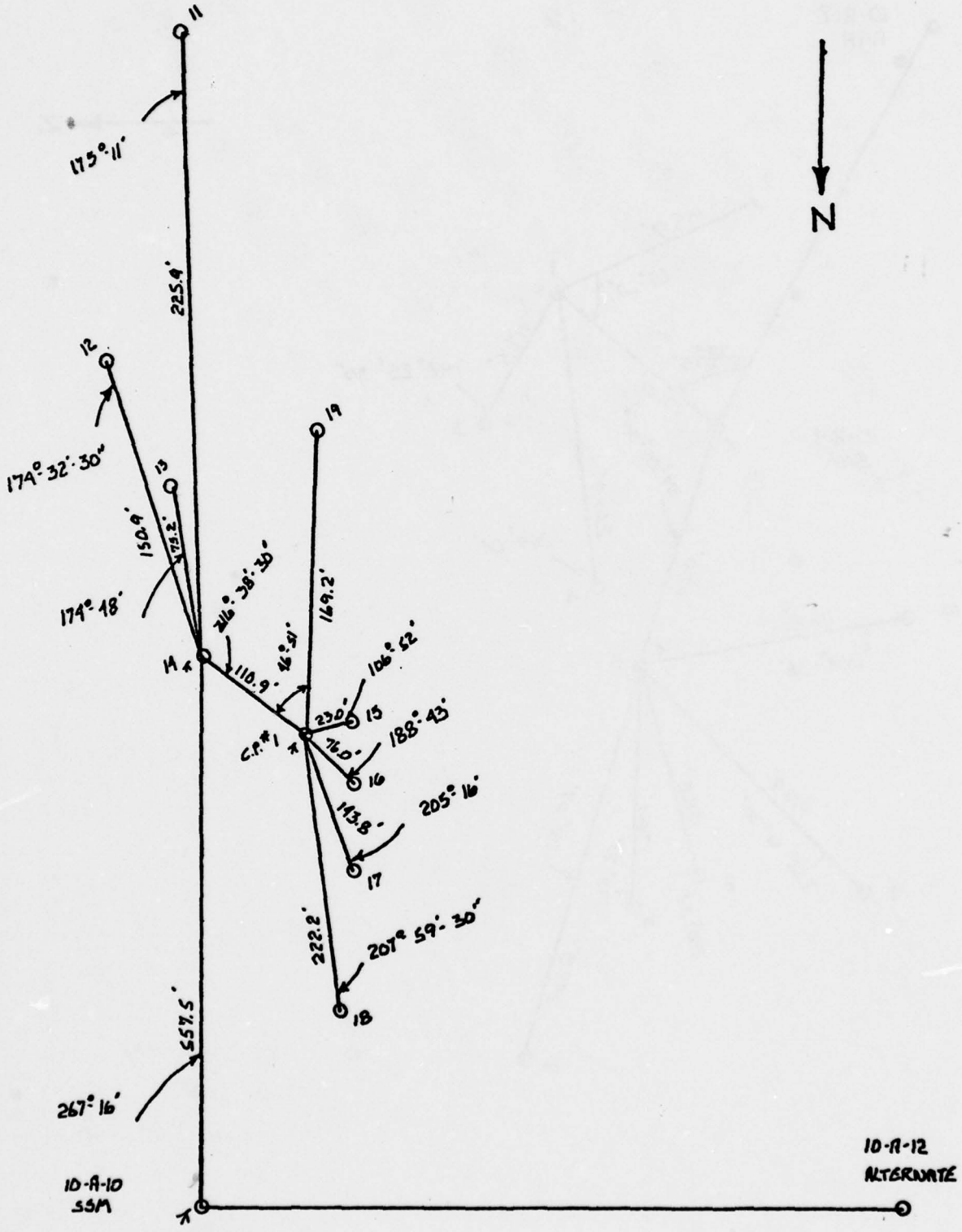
Summer UPD-X

Survey Data

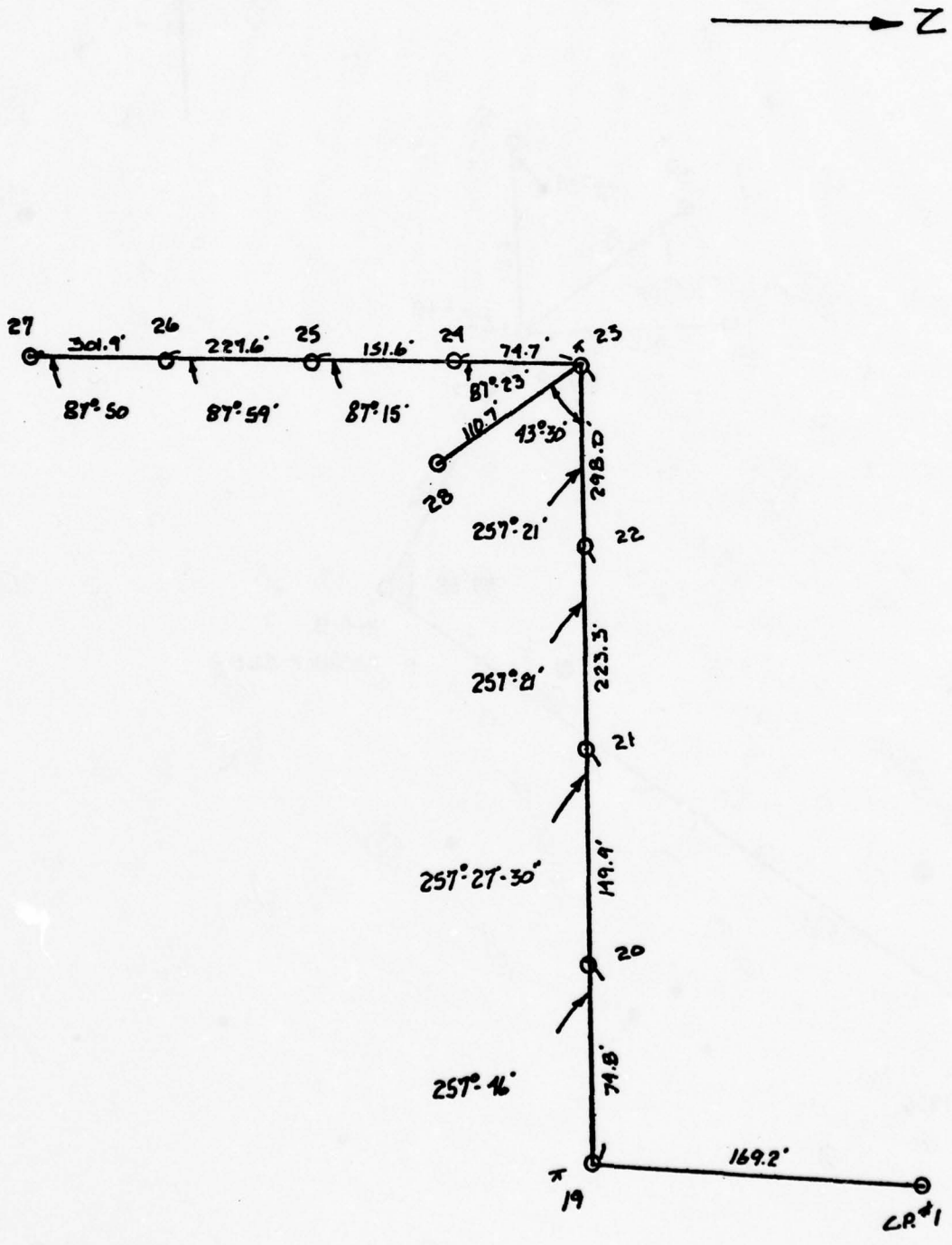
UPD-X Field Survey Data - Situation 1C Sam Site (Not to Scale)



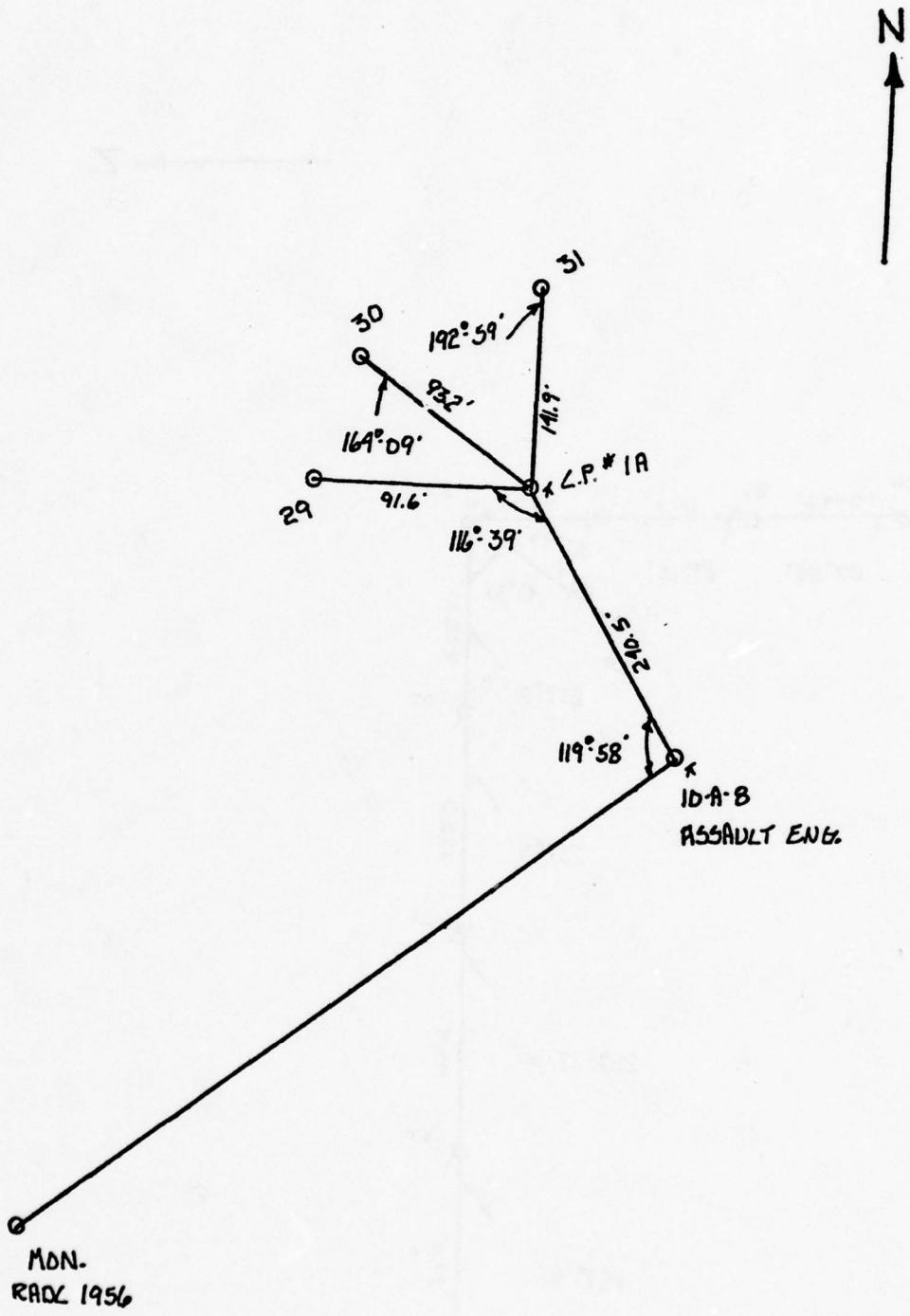
UPD-X Field Survey Data - Situation 1C Rock Pile Convoy (Not to Scale)



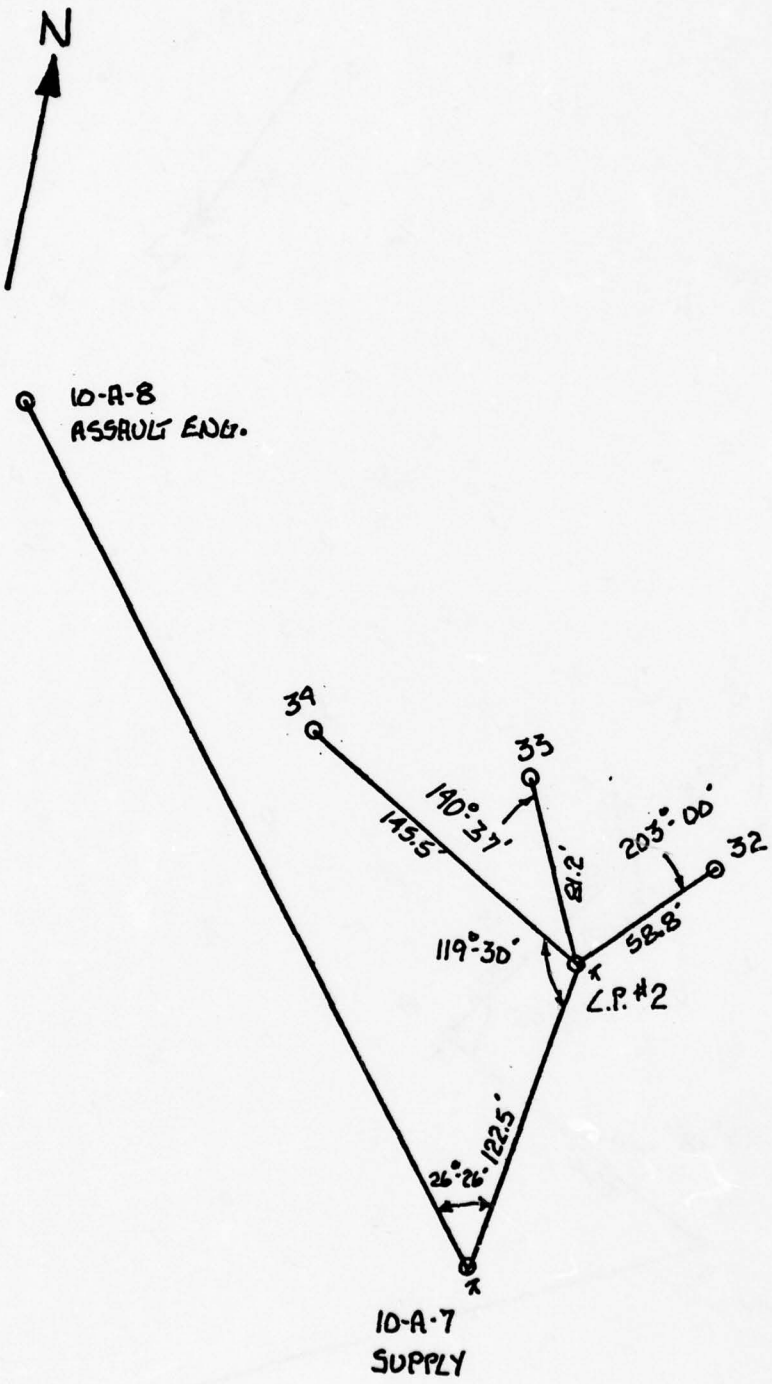
UPD-X Field Survey Data - Situation 1C Armor (Not to Scale)



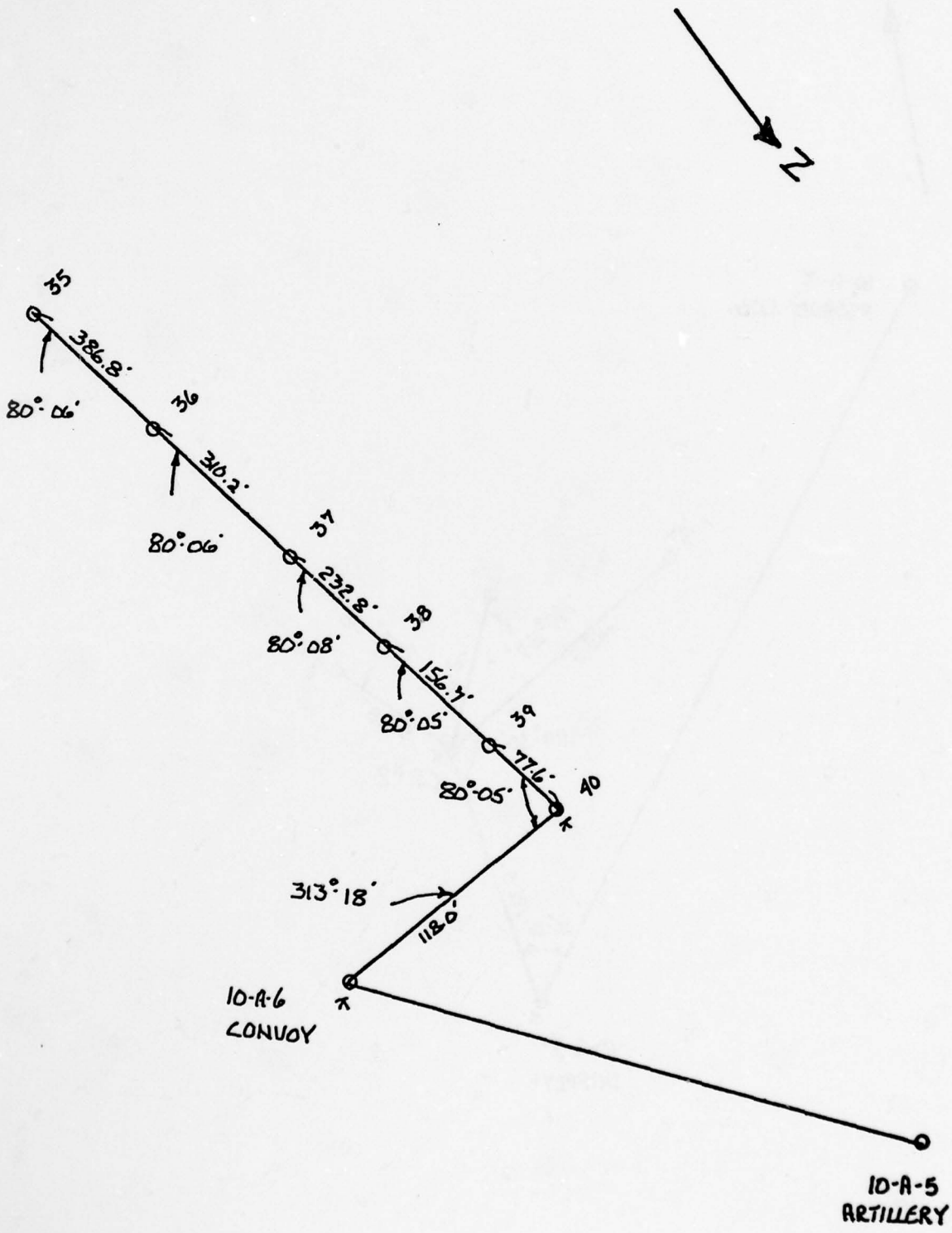
UPD-X Field Survey Data - Situation 1C Artillery (Not to Scale)



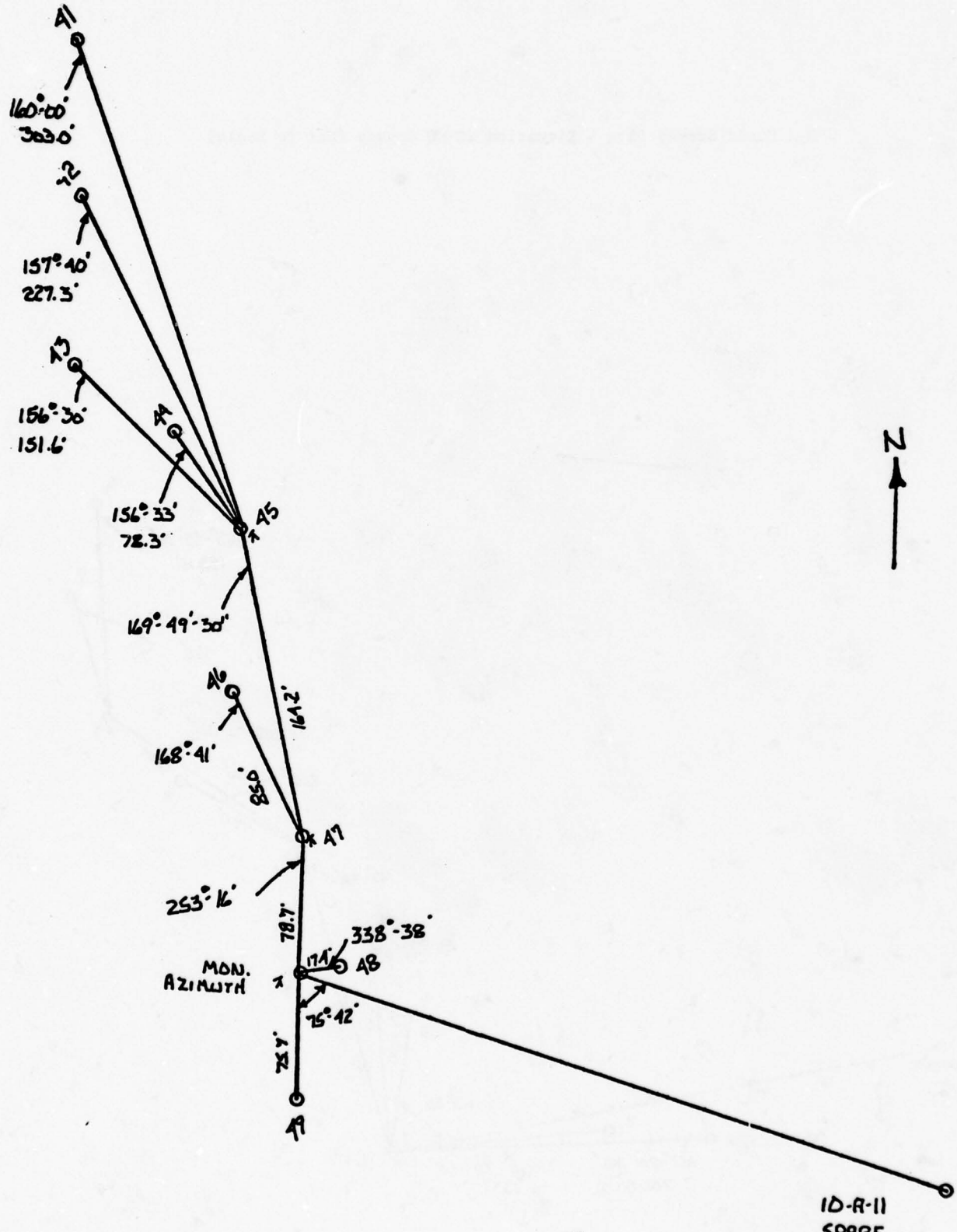
UPD-X Field Survey Data - Situation 1C Missles (Not to Scale)



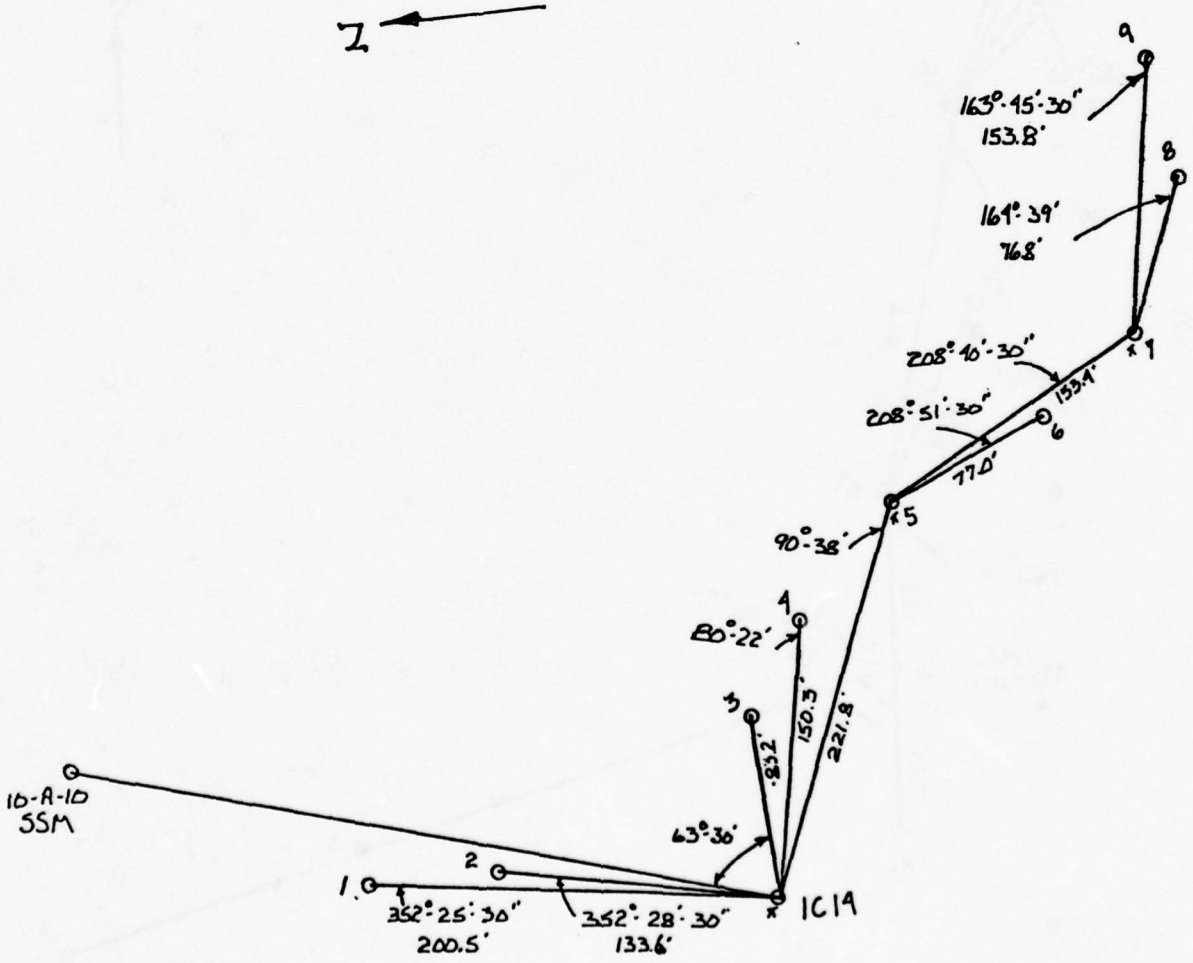
UPD-X Field Survey Data - Situation 1C County Rd. Convoy (Not to Scale)



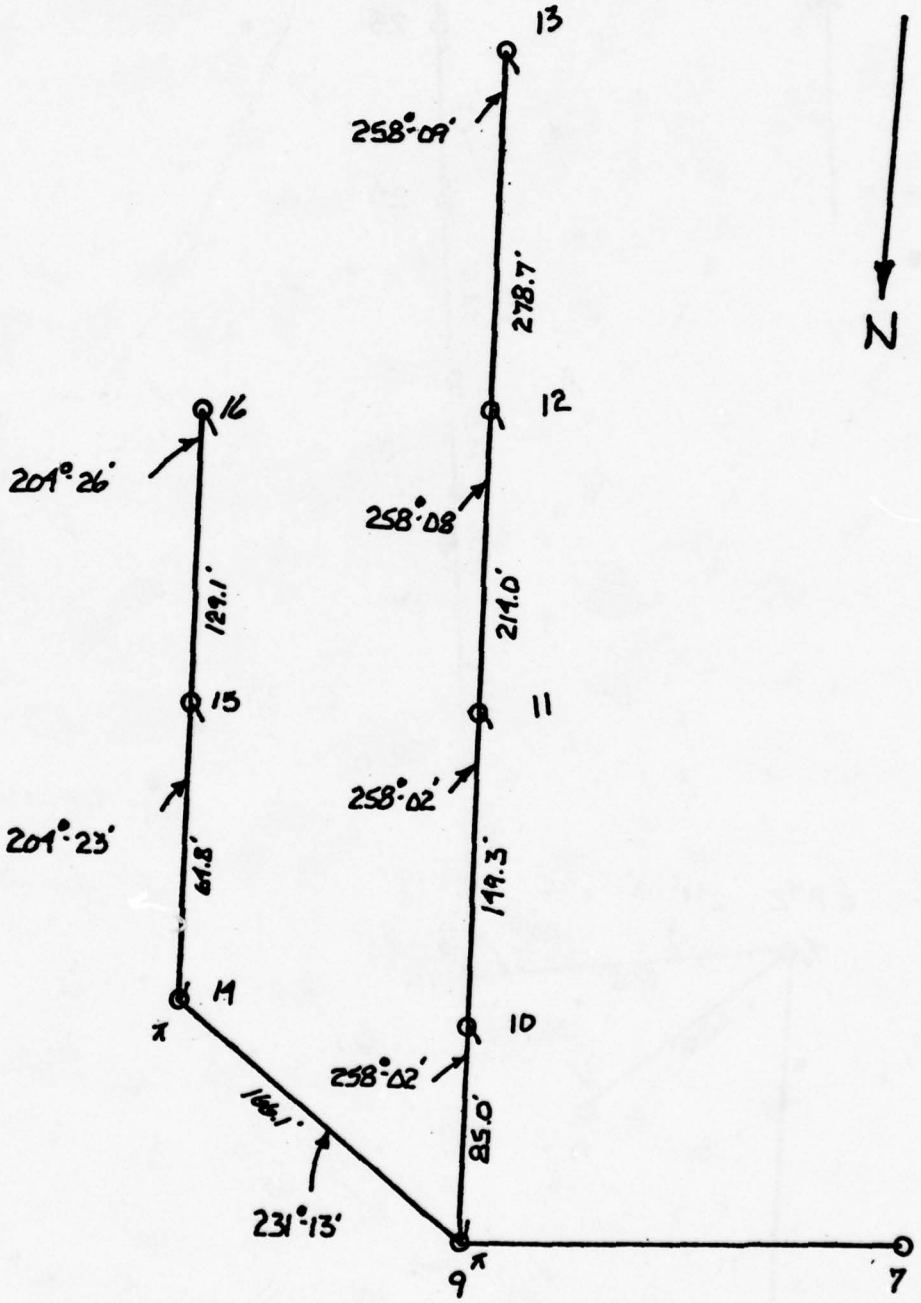
UPD-X Field Survey Data - Situation 1C Plateau Rd. Convoy (Not to Scale)



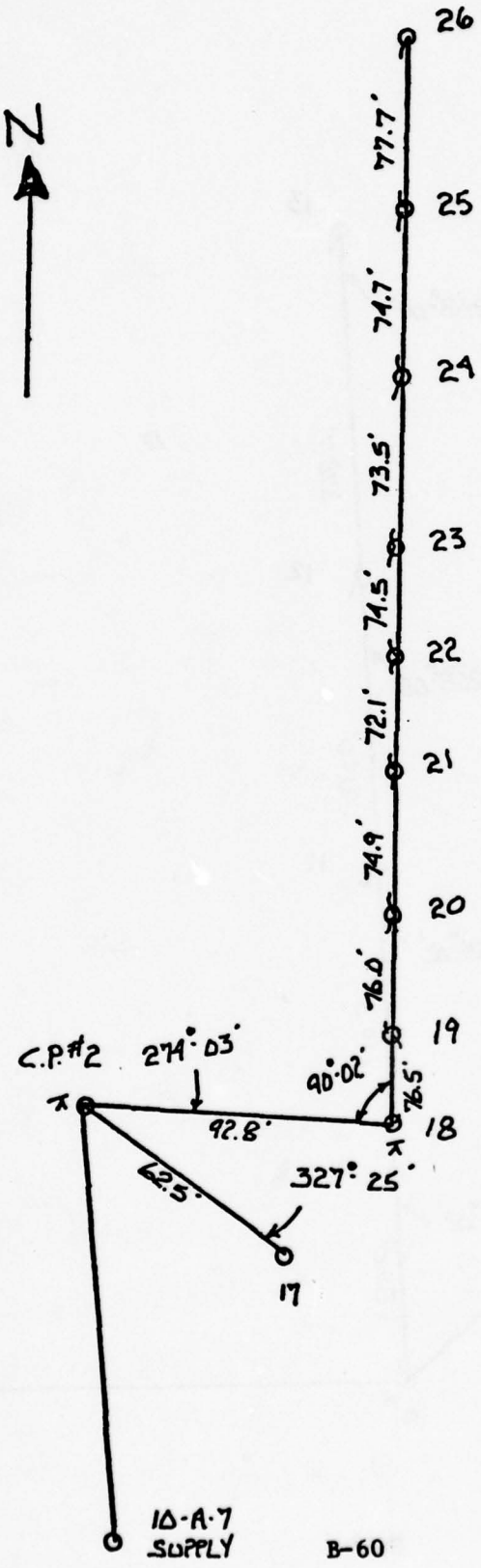
UPD-X Field Survey Data - Situation 2C HQ Convoy (Not to Scale)



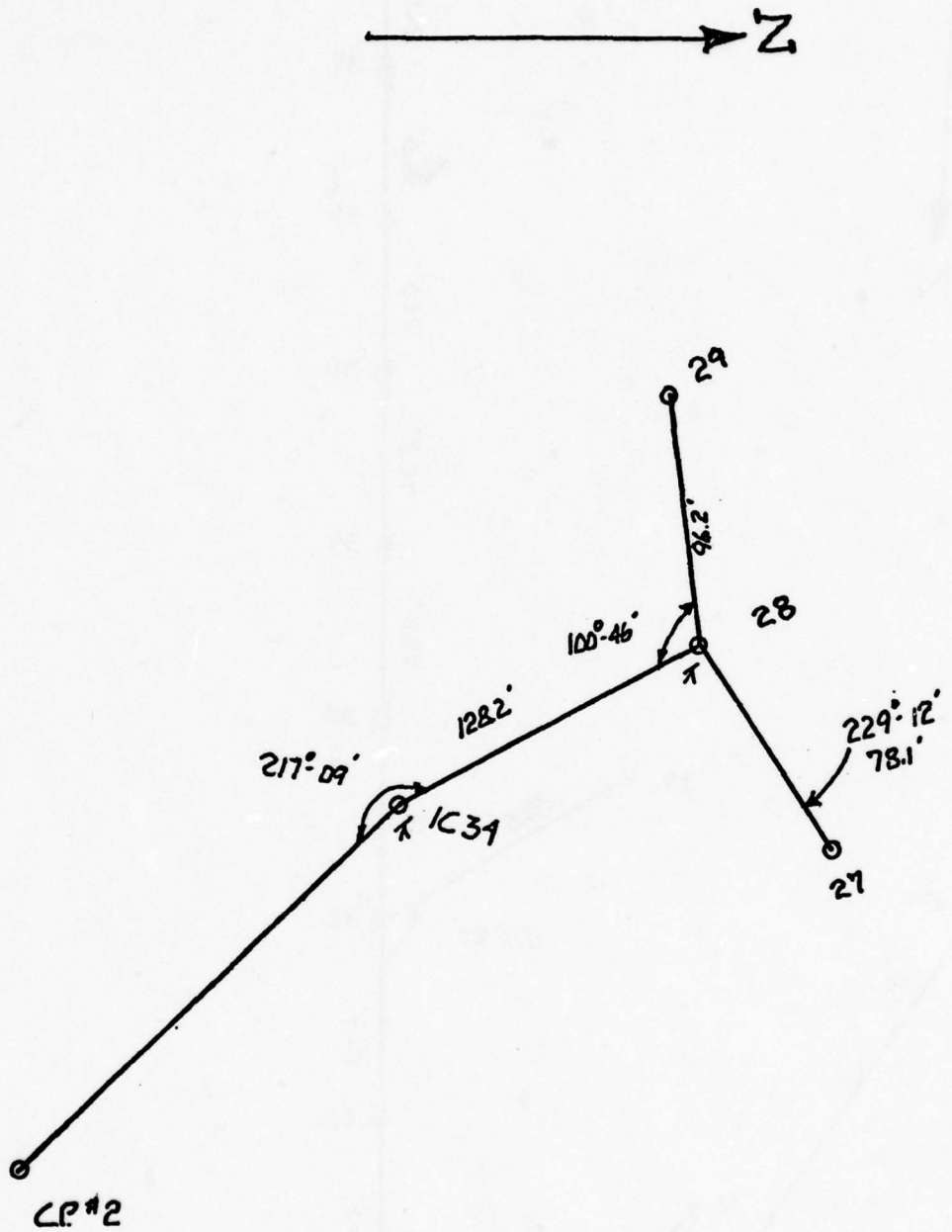
UPD-X Field Survey Data - Situation 2C HQ Jeep Array (Not to Scale)



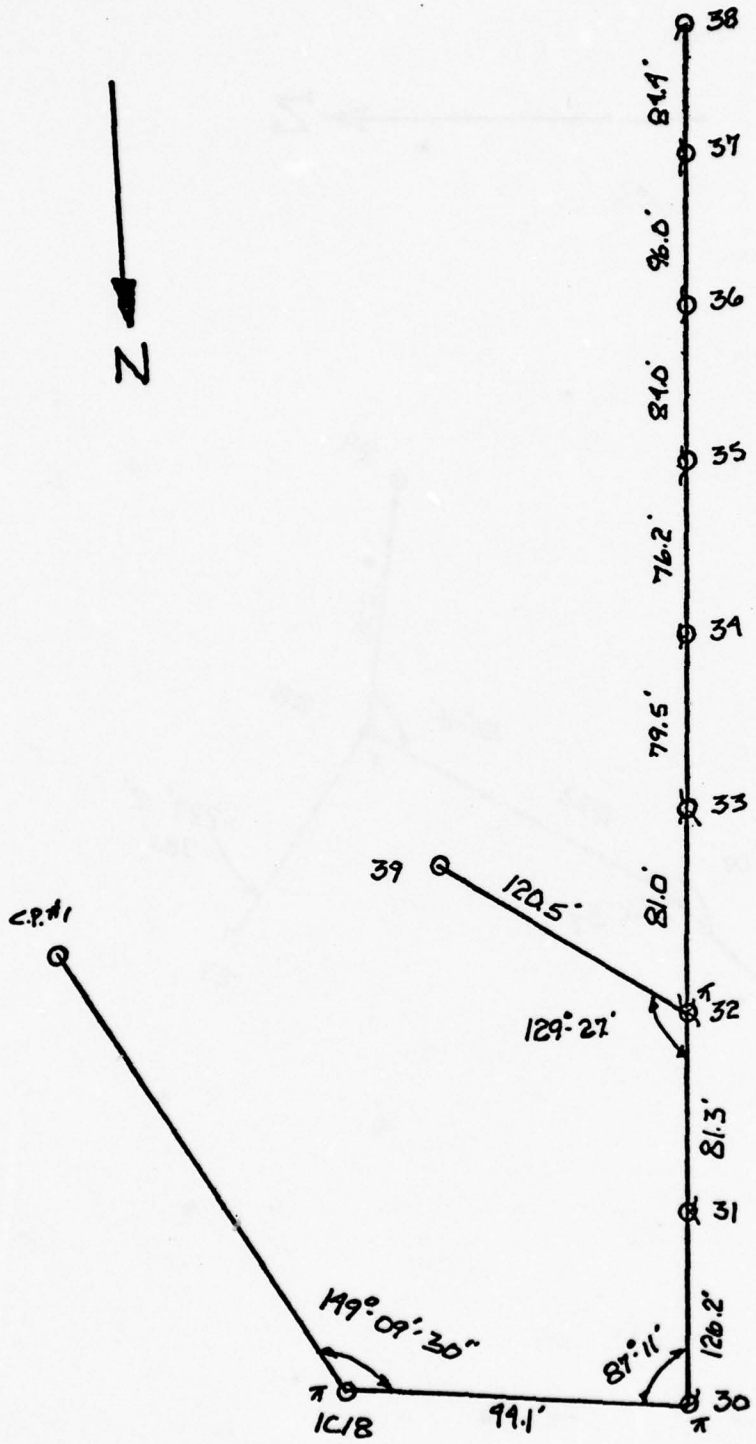
UPD-X Field Survey Data - Situation 2C Supply Site Convoy (Not to Scale)



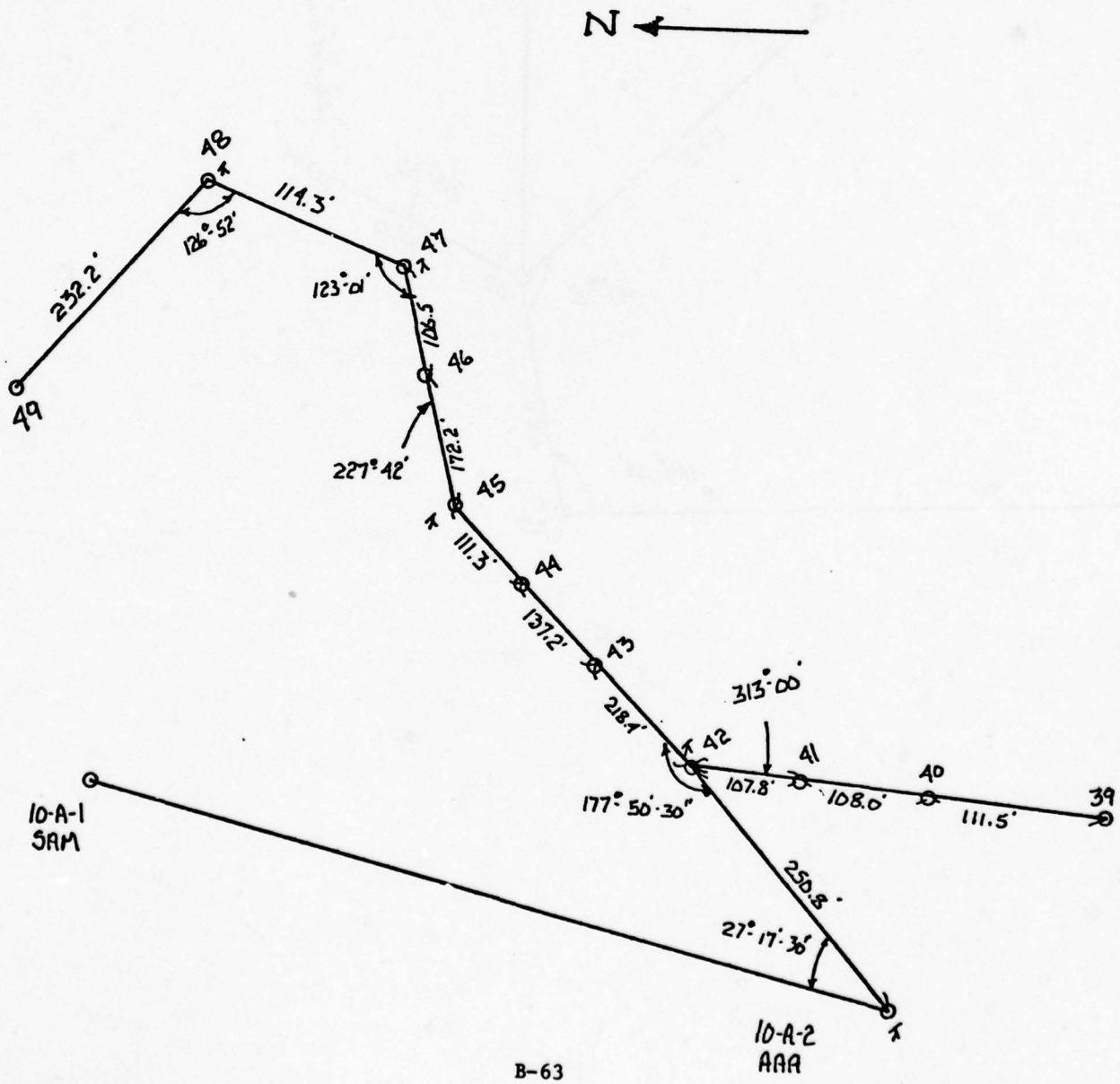
UPD-X Field Survey Data - Situation 2C Missles (Not to Scale)



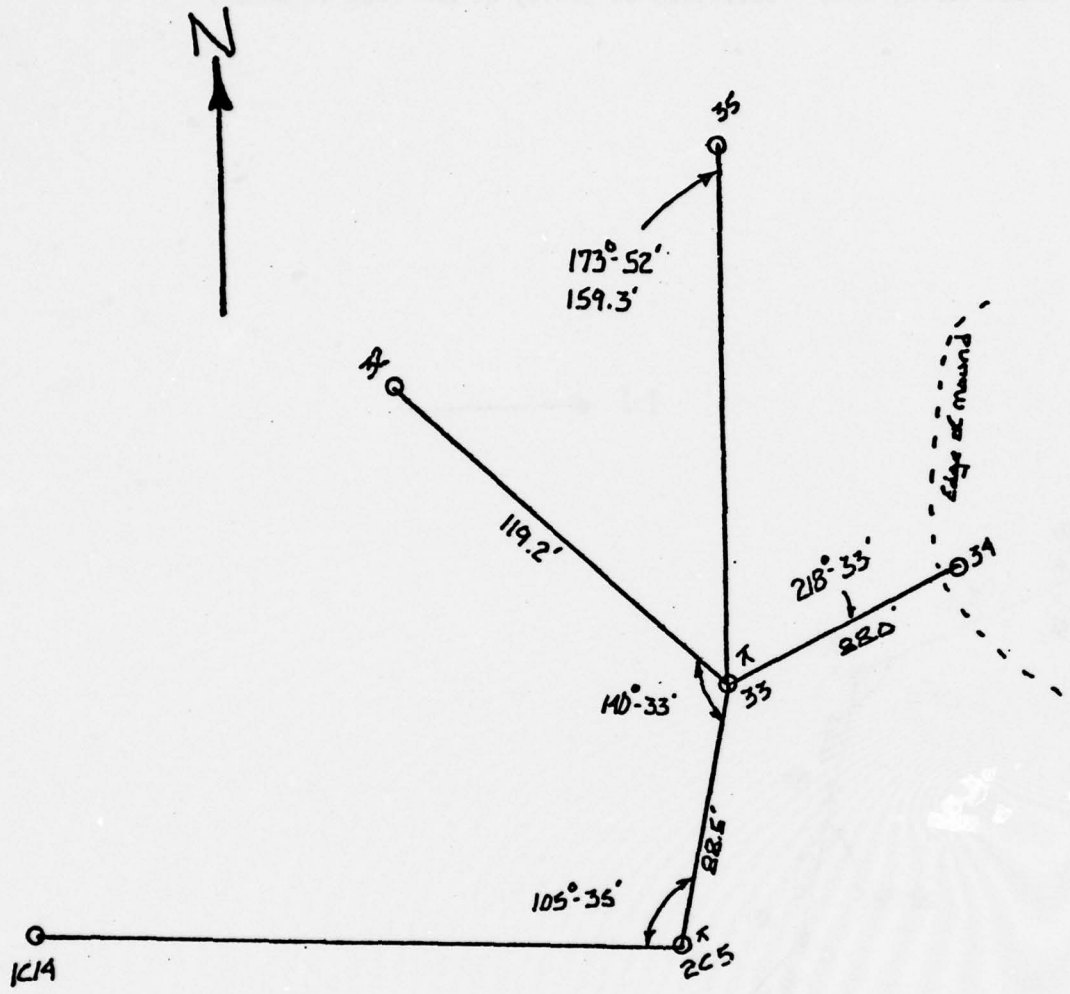
UPD-X Field Survey Data - Situation 2C Armor (Not to Scale)



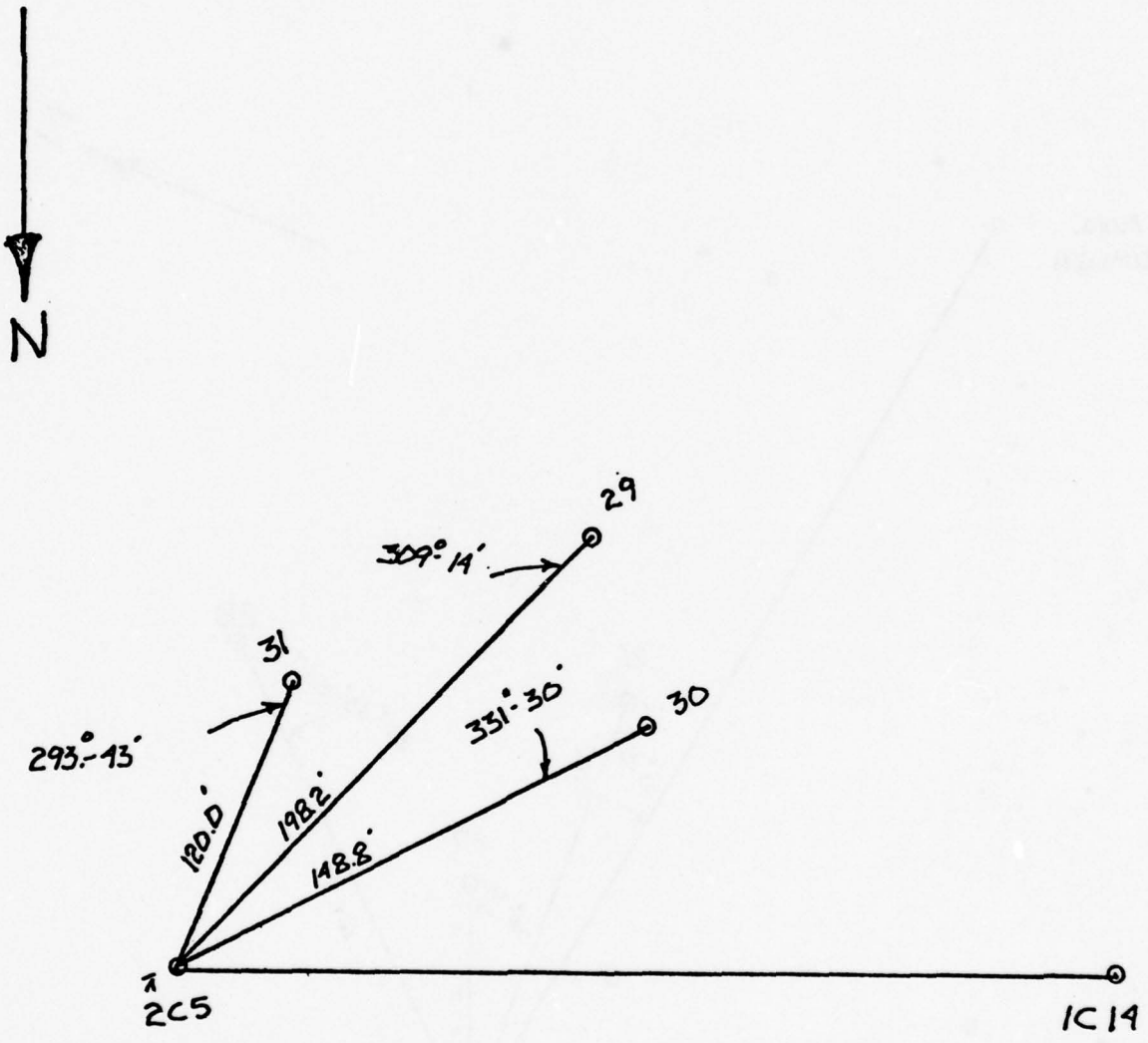
UPD-X Field Survey Data - Situation 3C Convoy at AAA (Not to Scale)



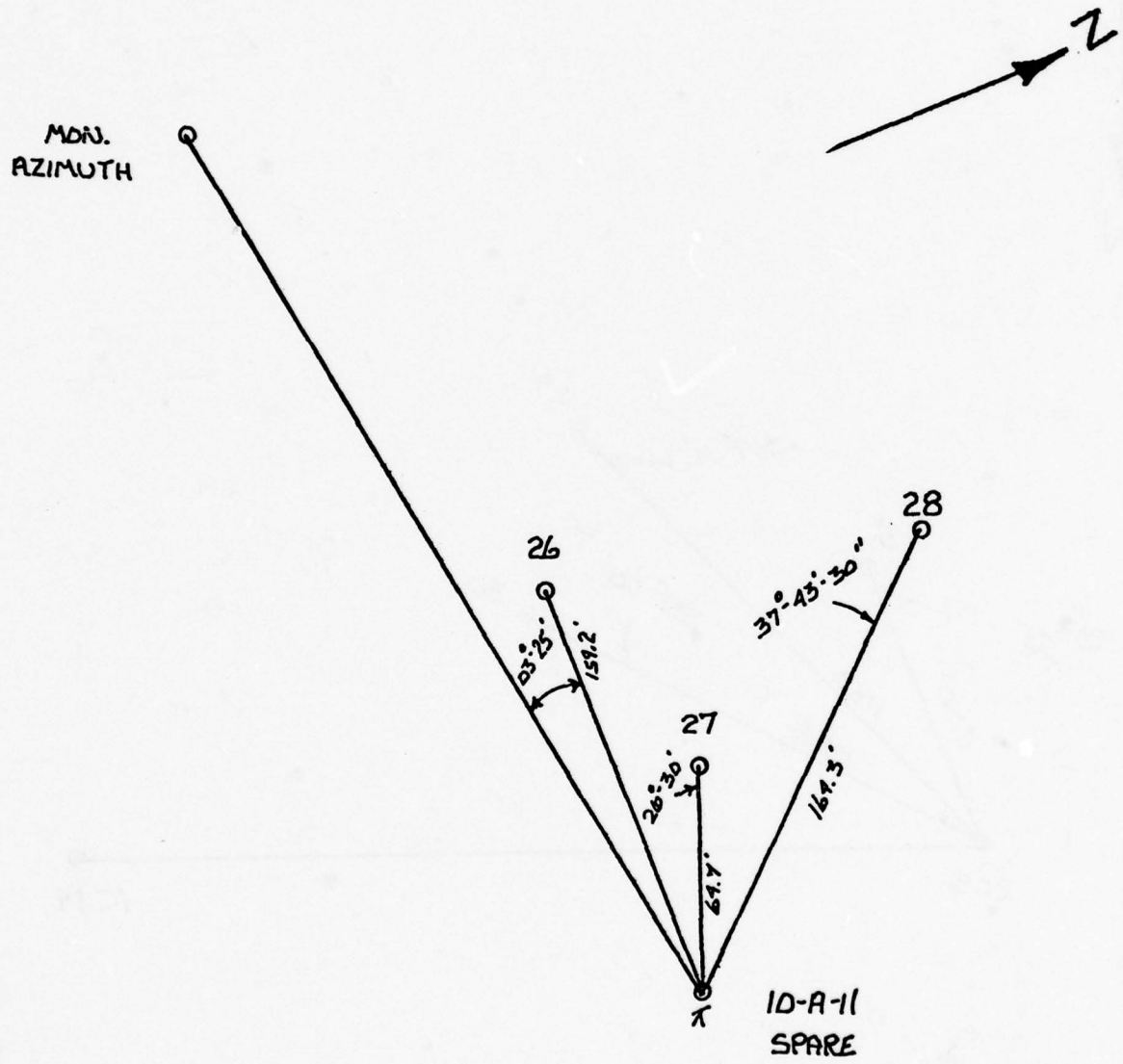
UPD-X Field Survey Data - Situation 3C Armor at Mound (Not to Scale)



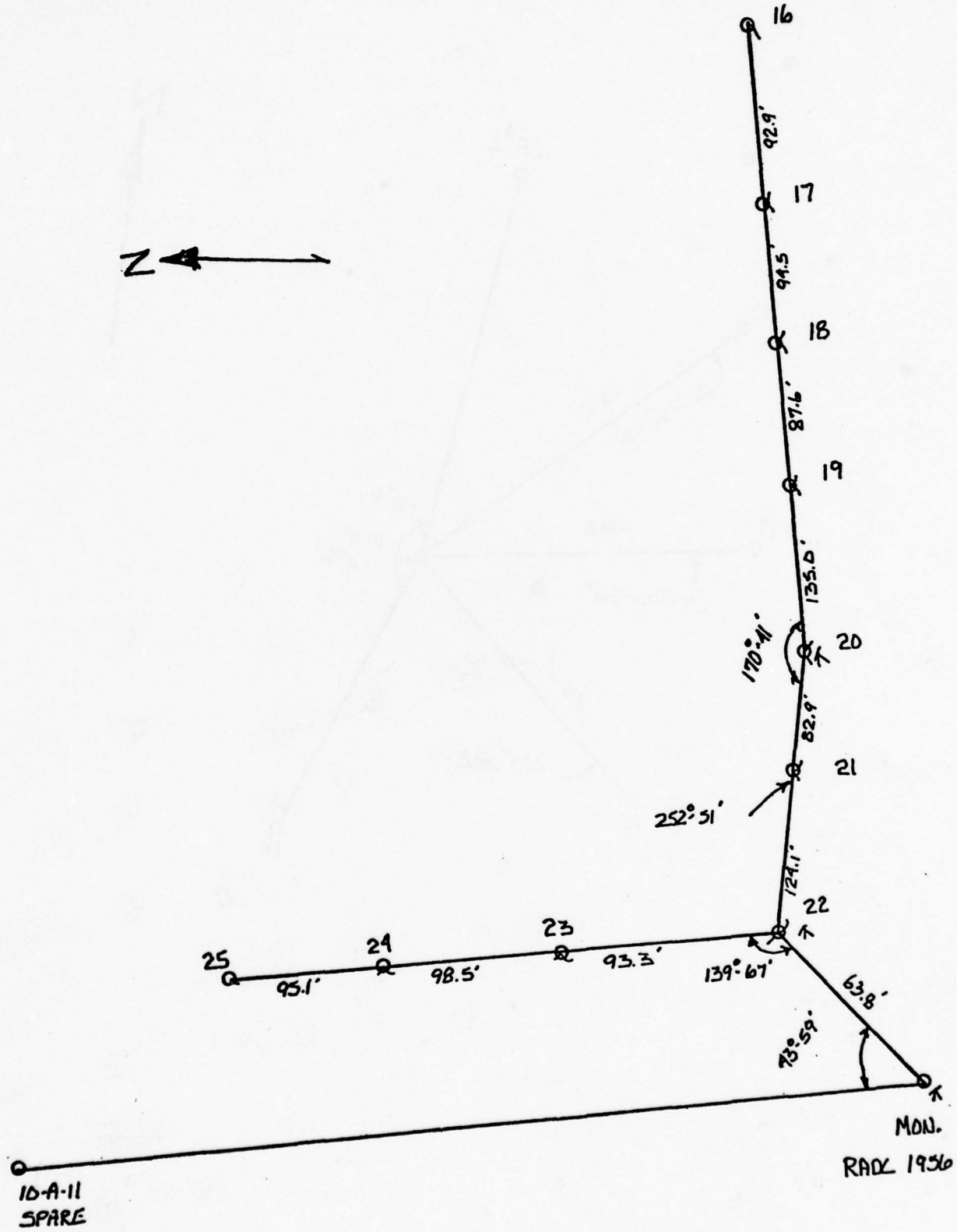
UPD-X Field Survey Data - Situation 3C Armor Near Mound (Not to Scale)



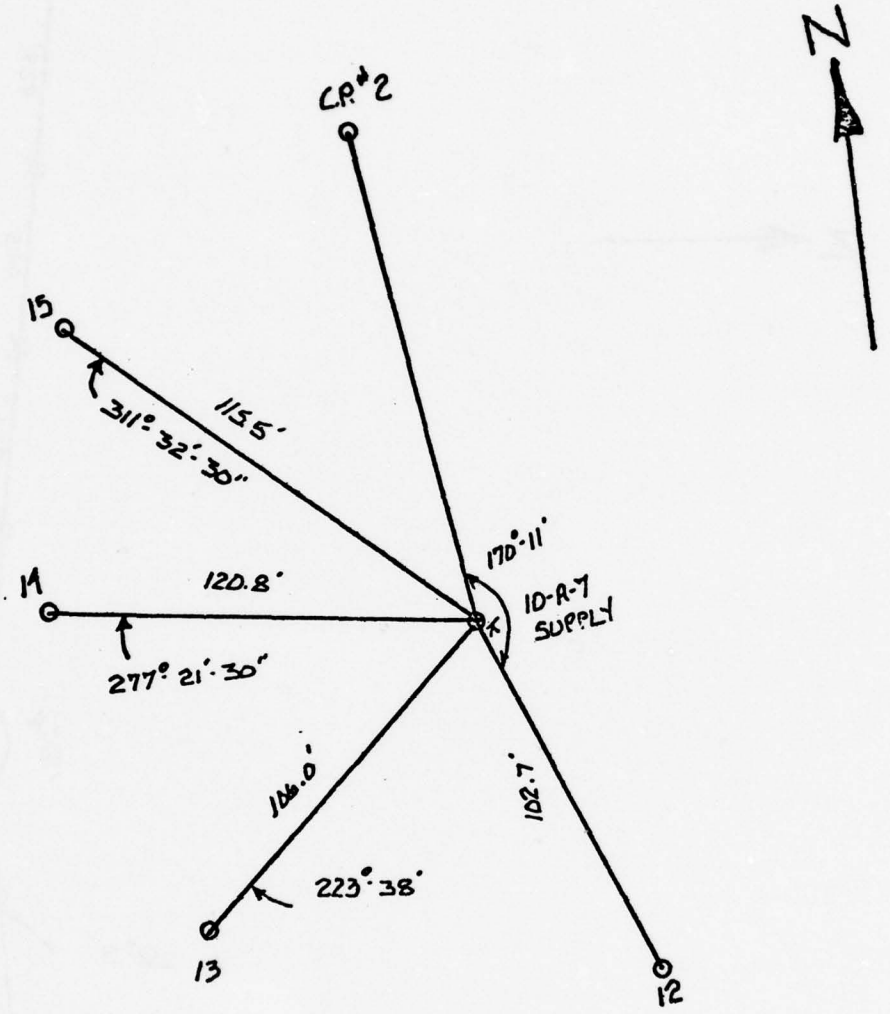
UPD-X Field Survey Data - Situation 3C Armor at Honest John (Not to Scale)



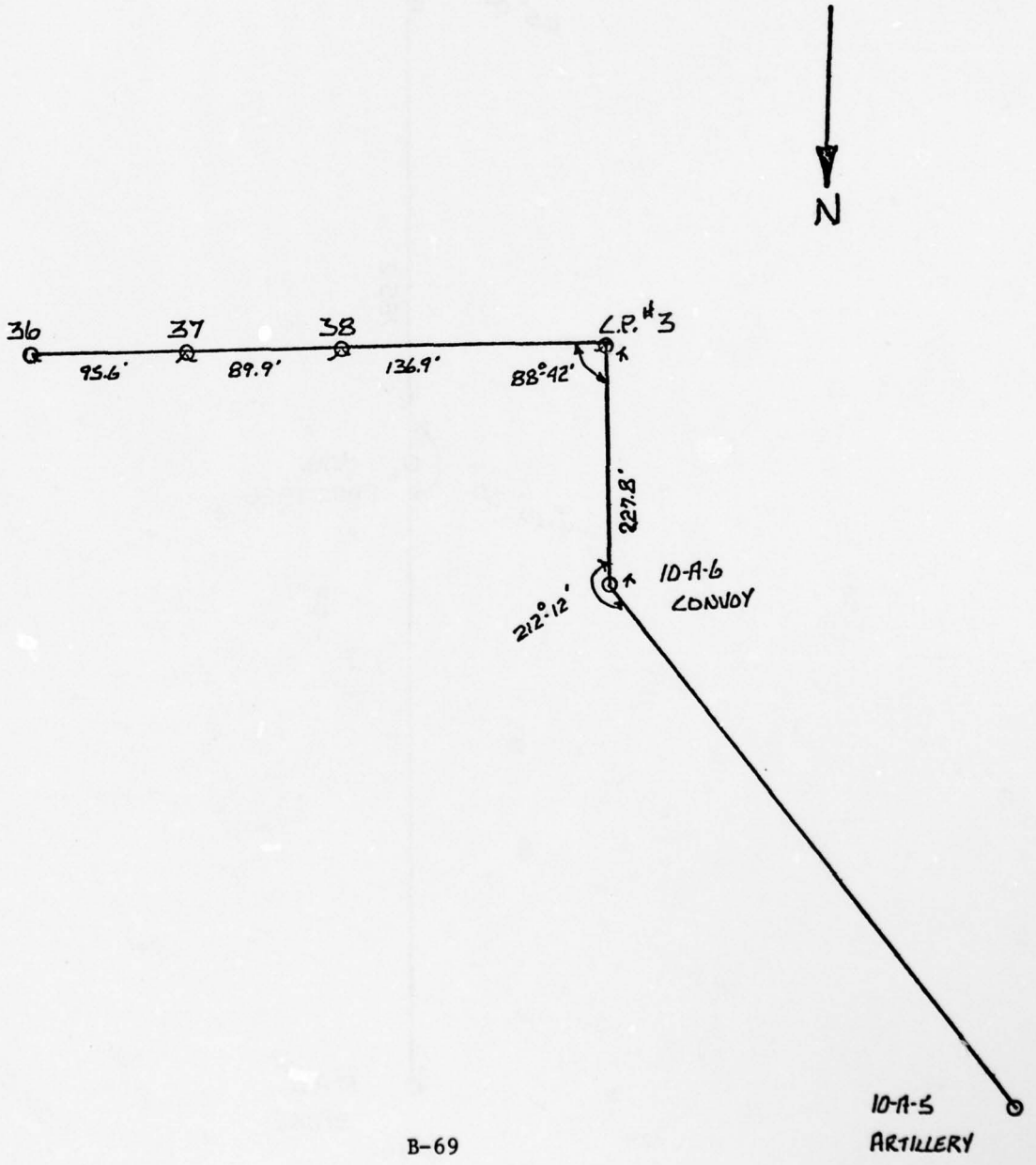
UPD-X Field Survey Data - Situation 3C Convoy at Crane Road (Not to Scale)



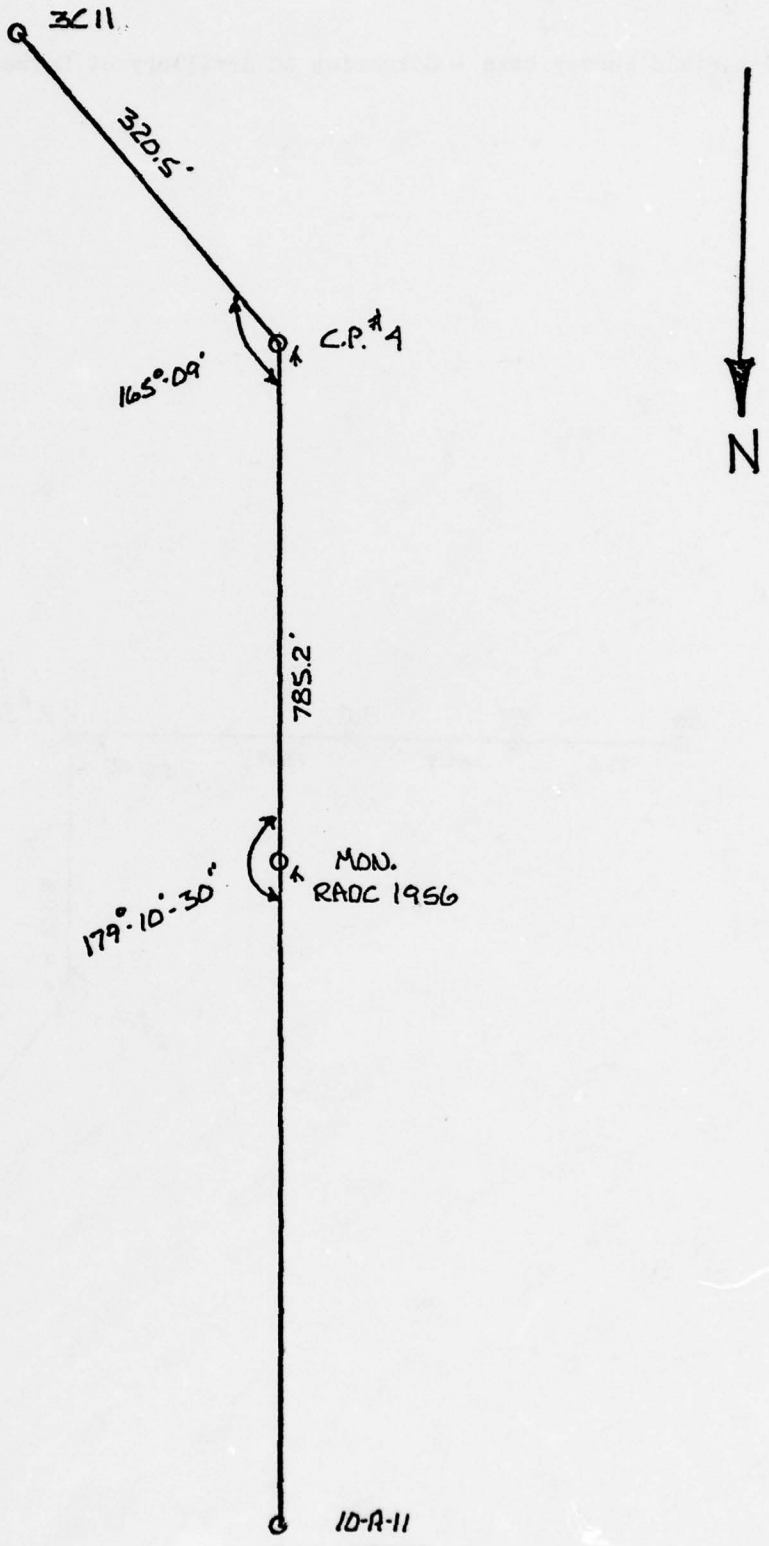
UPD-X Field Survey Data - Situation 3C Jeeps at Supply (Not to Scale)



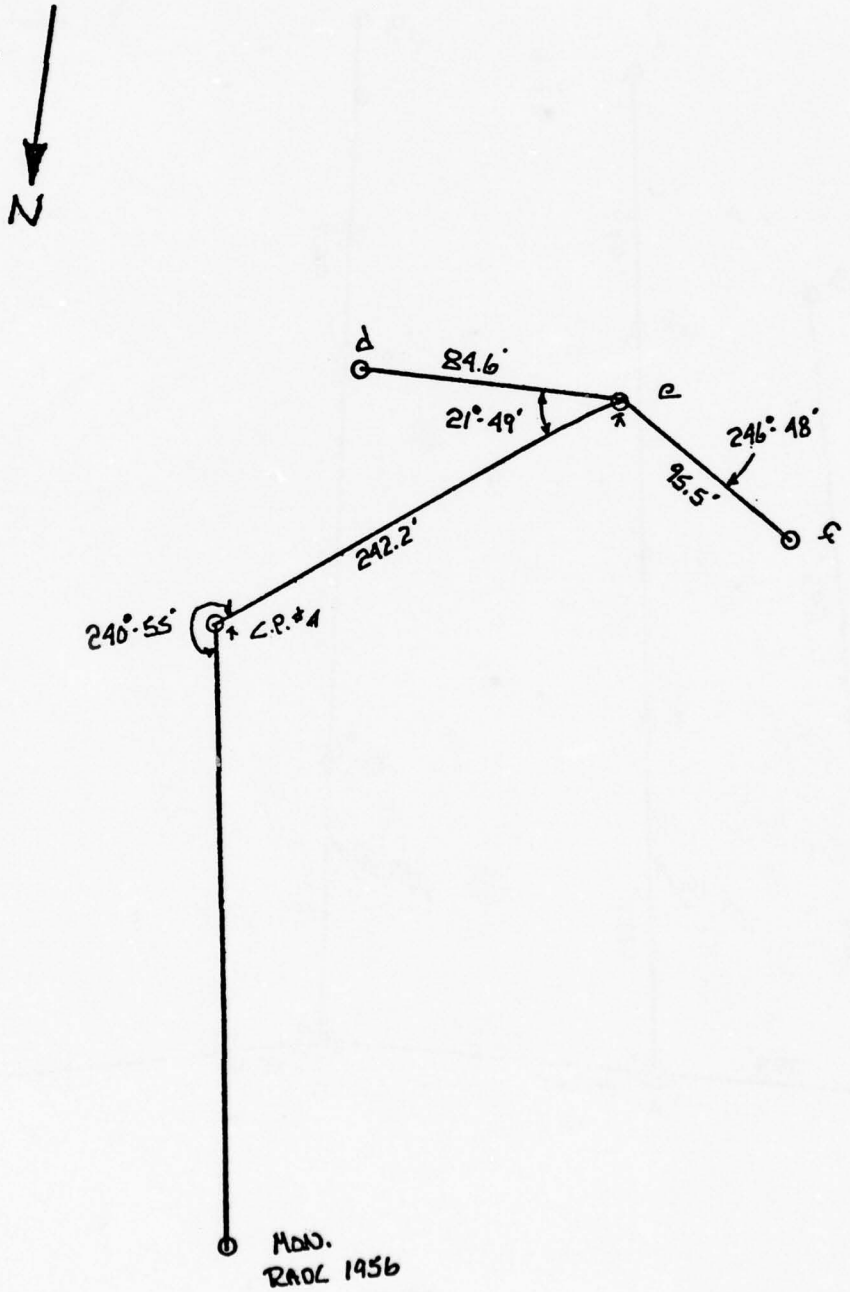
UPD-X Field Survey Data - Situation 3C Artillery at Entrance Field West (Not to Scale)



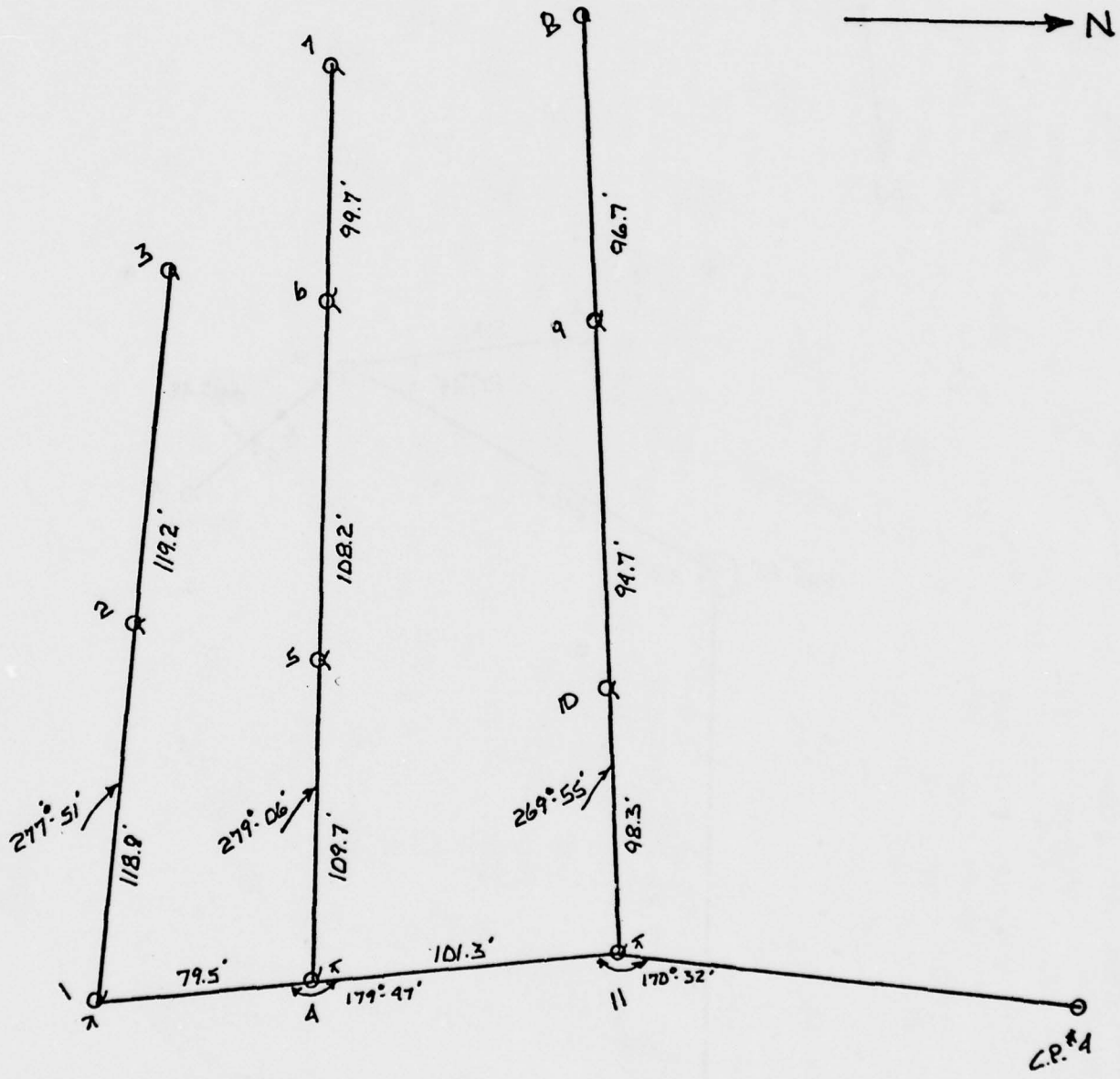
UPD-X Field Survey Data - Situation 3C & 2C Control Point 4 (Not to Scale)



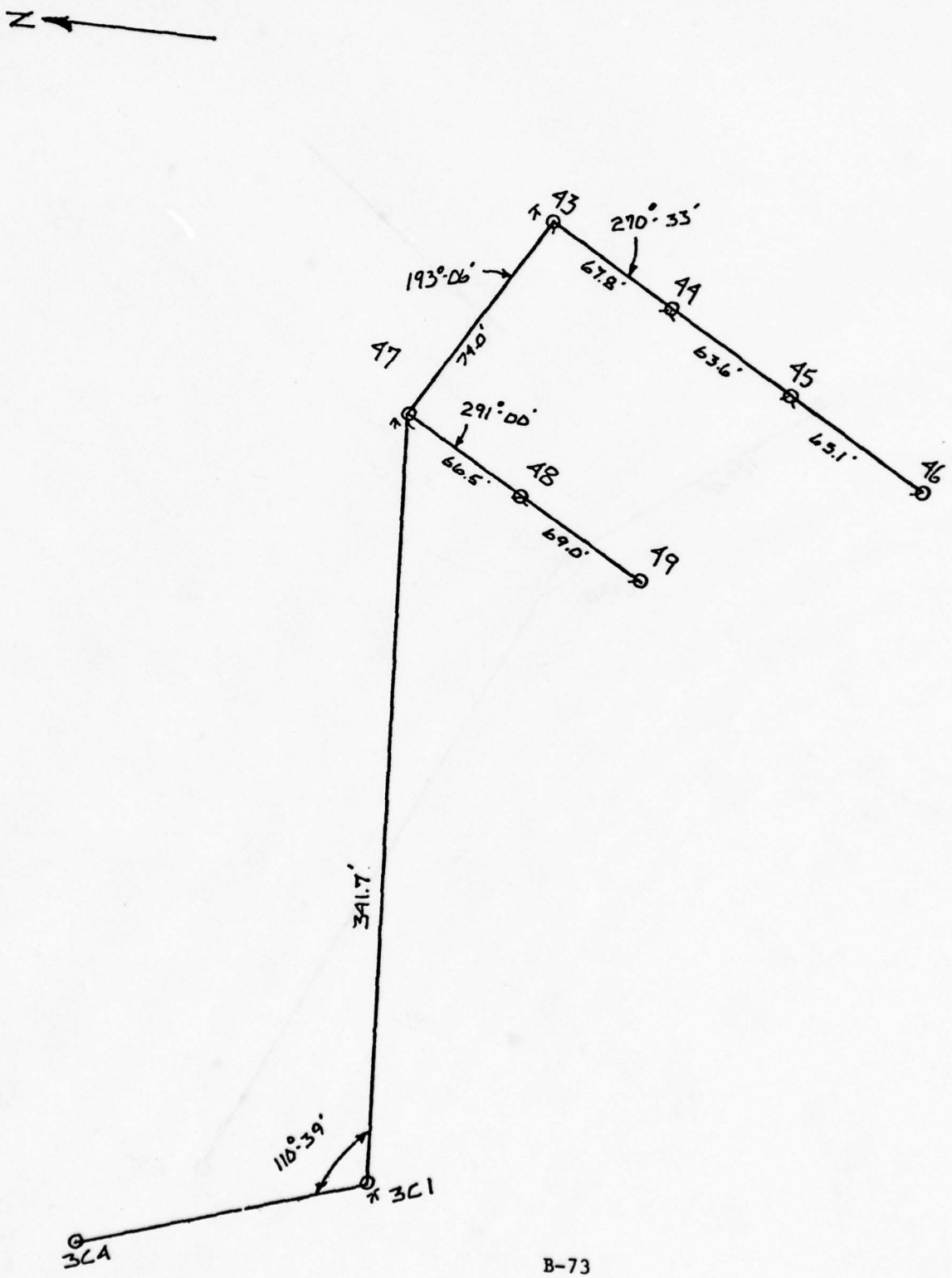
UPD-X Field Survey Data - Situation 2C Artillery at County Road (Not to Scale)



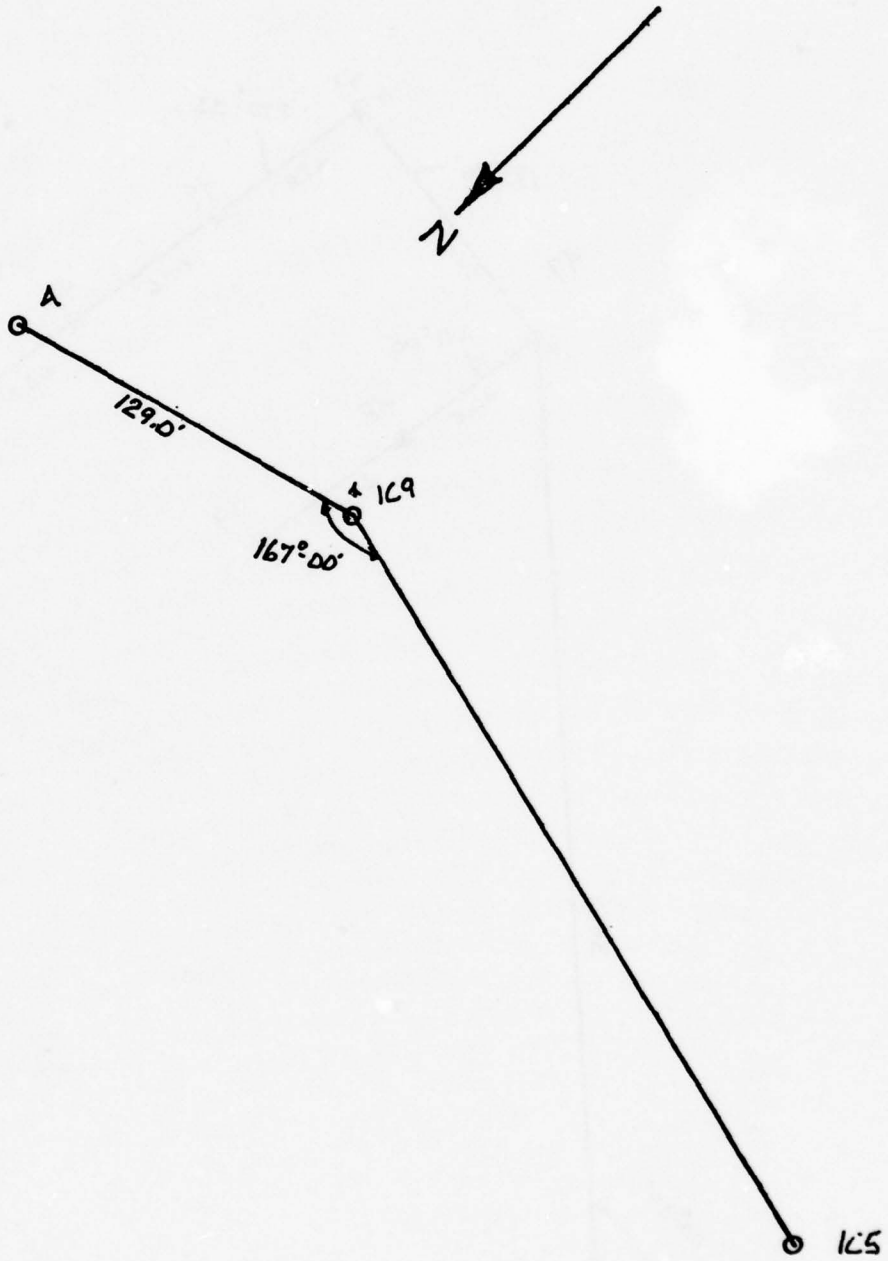
UPD-X Field Survey Data - Situation 3C Mixed Array at County Road (Not to Scale)



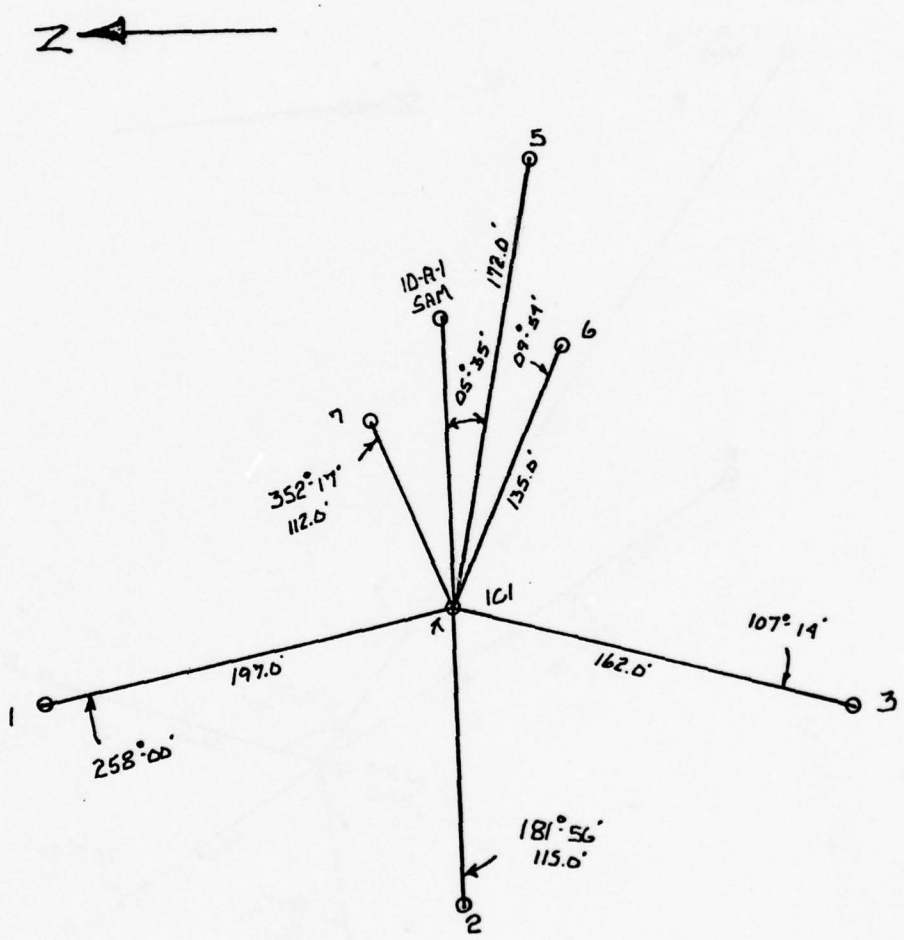
UPD-X Field Survey Data - Situation 2C Trucks at County Road (Not to Scale)



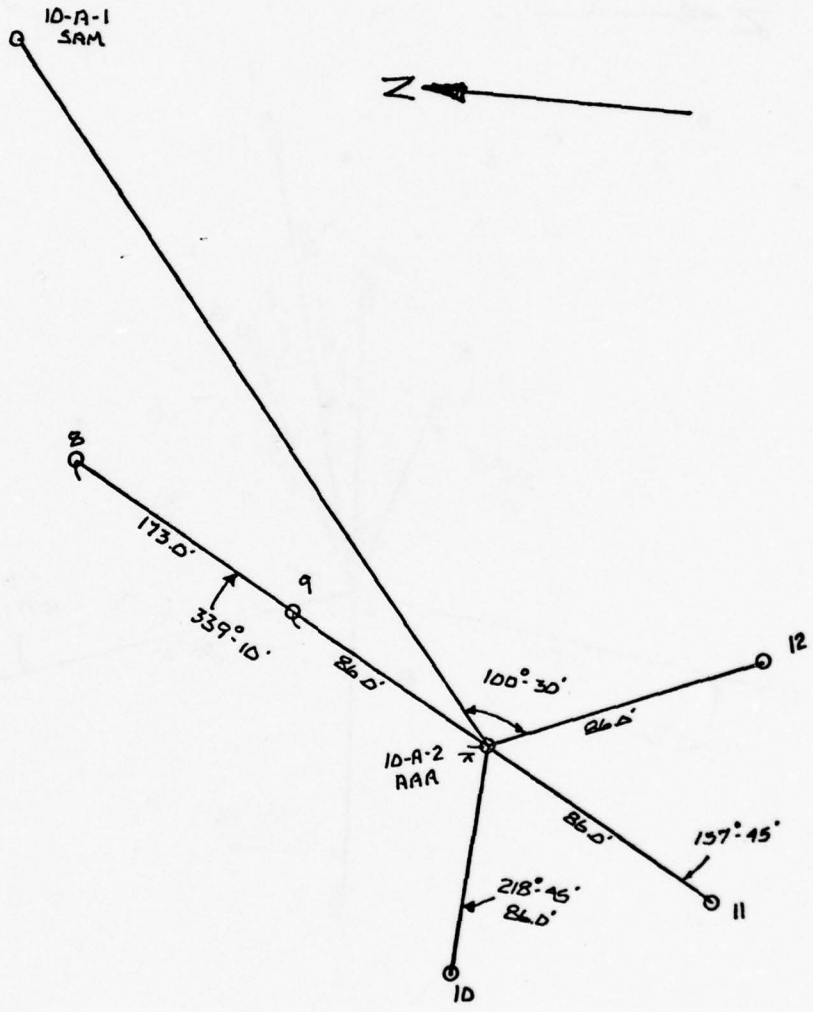
UPD-X Field Survey Data - Static Targets Sam Site (Not to Scale)



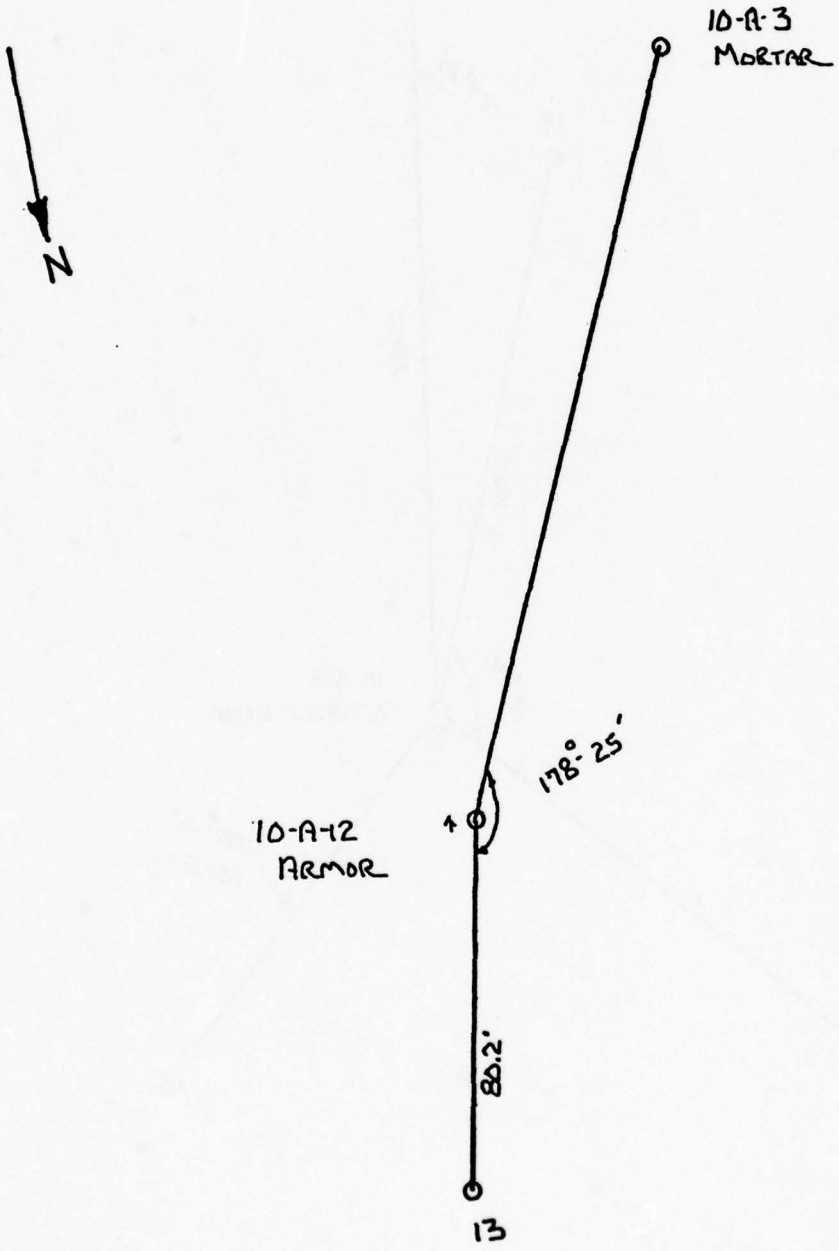
UPD-X Field Survey Data - Static Targets Sam Site (All Targets Shot to Center) (Not to Scale)



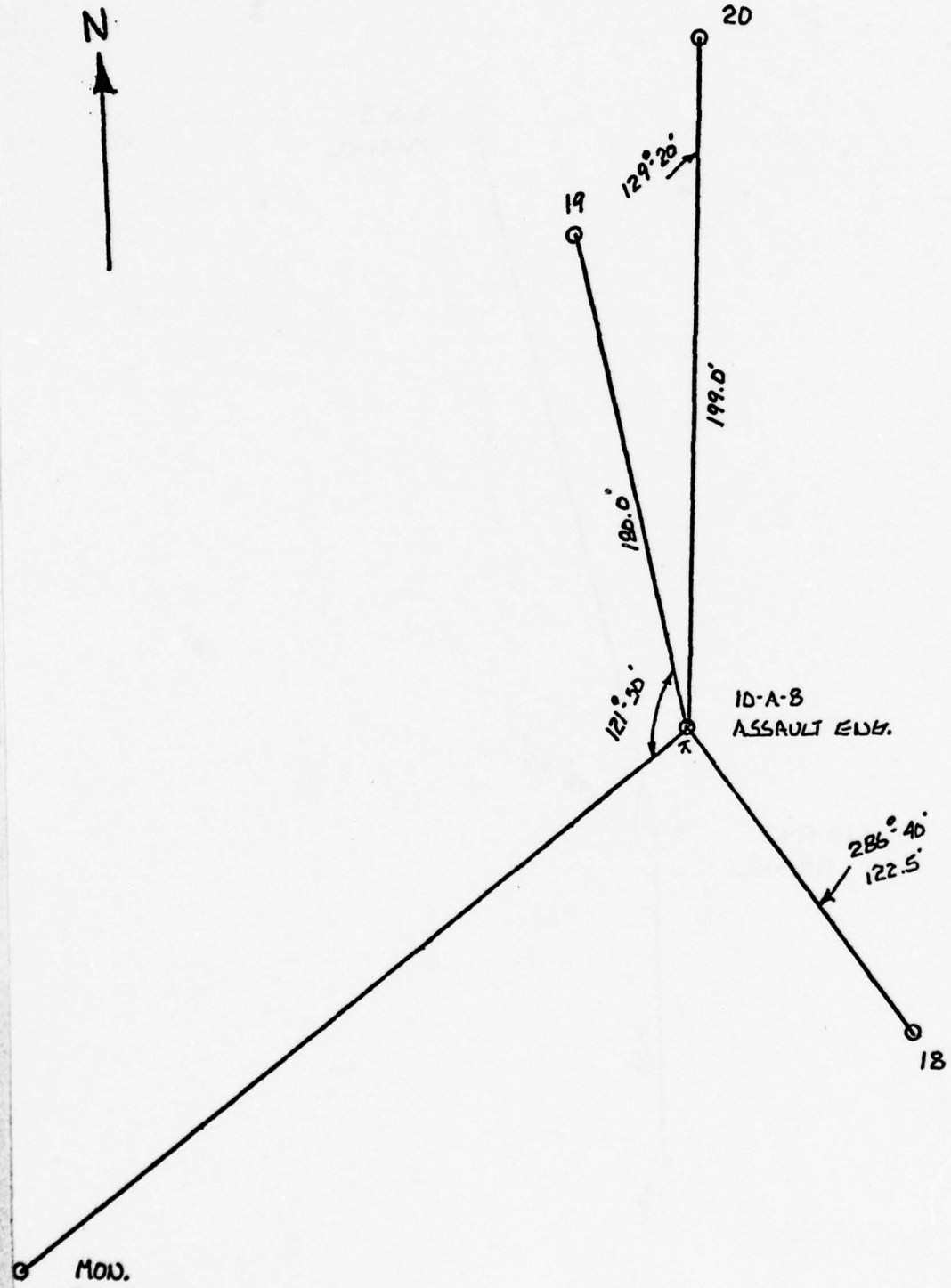
UPD-X Field Survey Data - Static Targets AAA Site (All Targets Shot to Center) (Not to Scale)



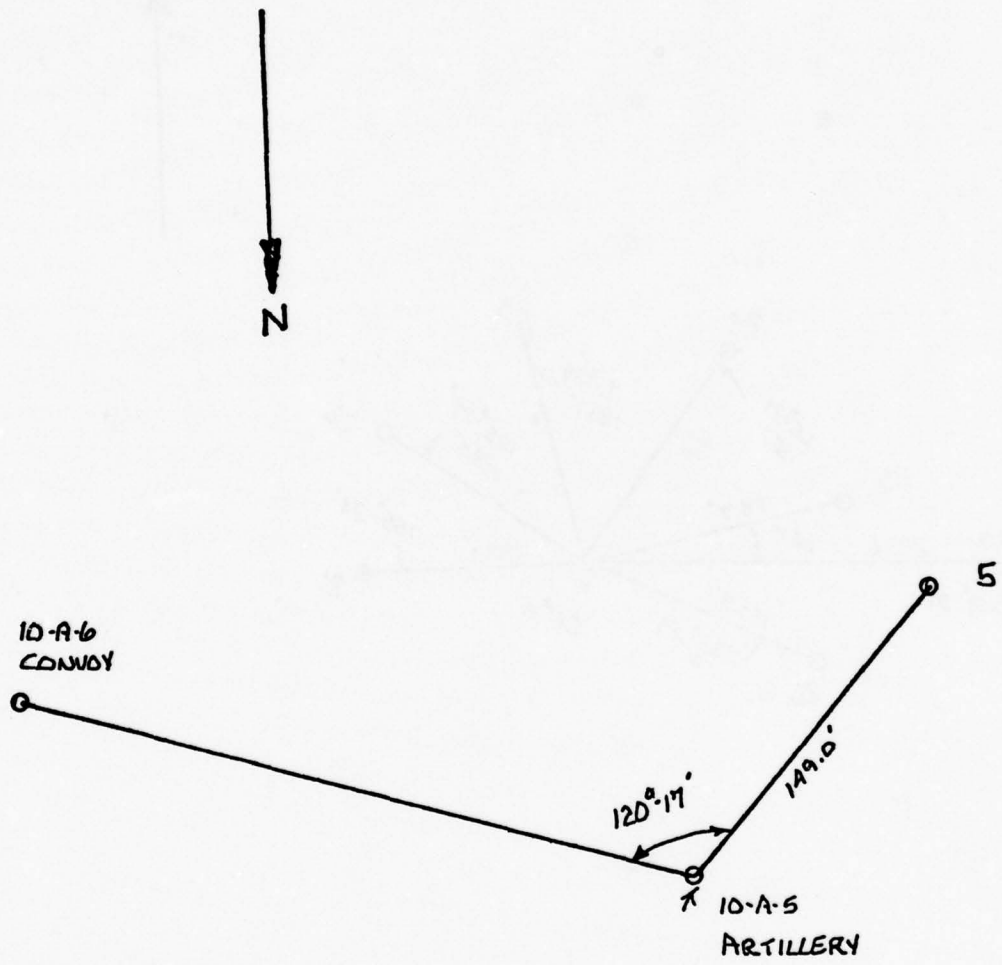
UPD-X Field Survey Data - Static Targets Armor (Not to Scale)



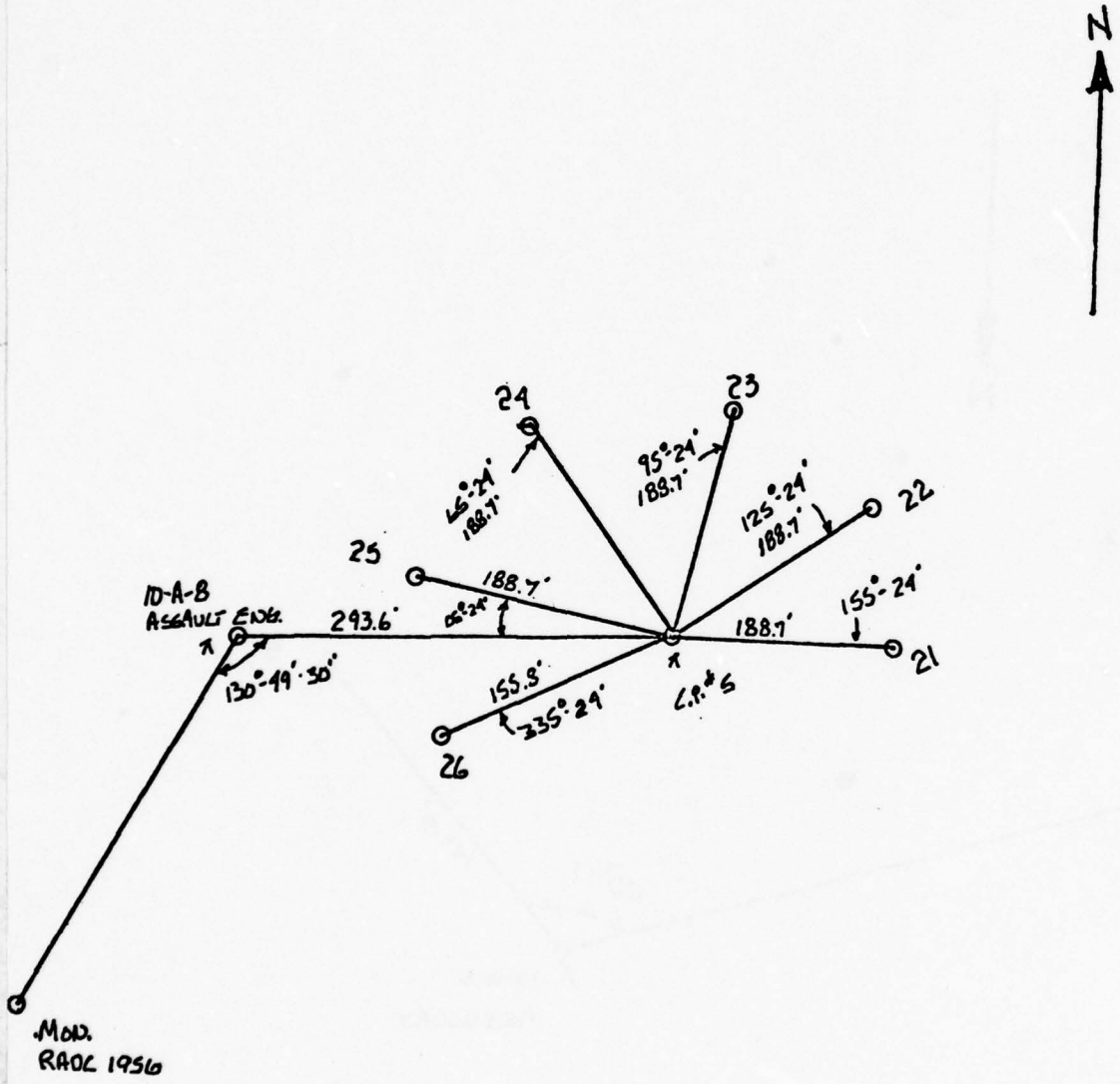
UPD-X Field Survey Data - Static Targets Assault Engineers (Not to Scale)



UPD-X Field Survey Data - Static Targets Artillery (Not to Scale)



UPD-X Field Survey Data - Static Targets Jeep Array (Not to Scale)



Page 1

UPD-X SURVEY DATA

MISSION NO. _____ SITUATION 1 C

EQUIPMENT TRUCKS & JEEPS LOCATION 10-A-1 (SAM SITE)

∠	BS	FS	ANGLE	DISTANCE ∠ TO FS
10-A-1 SAM	10-A-2 AAA	1	48° - 15"	131.0'
10-A-1	10-A-2	5	214° - 28' - 30"	117.0'
1	10-A-1	2	65° - 20'	145.9'
1	10-A-1	3	292° - 25' - 30"	117.3'
1	10-A-1	4	319° - 04'	264.9'
5	10-A-1	6	181° - 07'	247.3'
5	10-A-1	7	193° - 20'	136.1'
5	10-A-1	8	230° - 32'	128.5'
5	10-A-1	9	258° - 51' - 30"	179.9'
5	10-A-1	10	304° - 36'	116.8'

UPD-X SURVEY DATA

MISSION NO. _____ SITUATION 1 C

EQUIPMENT CONVOY LOCATION ROCK PILE

∧	BS	FS	ANGLE	DISTANCE ∧ TO FS
10-A-10 SSM	10-A-12 ALTERN.	14	267° - 16'	557.5'
14	10-A-10	13	174° - 48'	75.2'
"	"	12	174° - 32' - 30"	150.9'
"	"	11	175° - 11'	225.9'
"	"	C.P.1	316° - 38' - 30"	110.9'
C.P. 1	14	19	46° - 51'	169.2'
"	"	15	106° - 52'	23.0'
"	"	16	188° - 43'	76.0'
"	"	17	205° - 16'	143.8'
"	"	18	207° - 59' - 30"	222.2'

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UPD-X SURVEY DATA

MISSION NO. _____ SITUATION 1 C

EQUIPMENT ARMOR LOCATION FLYING VEE

⍲	BS	FS	ANGLE	DISTANCE ⍲ TO FS
19	C.P. 1	20	257° - 46'	74.8'
"	"	21	257° - 27' - 30"	149.9'
"	"	22	257° - 21'	223.3'
"	"	23	"	298.0'
23	19	28	43° - 30'	110.7'
"	"	24	87° - 23'	74.7'
"	"	25	87° - 15'	151.6'
"	"	26	87° - 59'	227.6'
"	"	27	87° - 50'	301.9'

UPD-X SURVEY DATA

MISSION NO. _____ SITUATION 1 C

EQUIPMENT ARTILLERY LOCATION HEADQUARTERS FIELD

∠	BS	FS	ANGLE	DISTANCE ∠ TO FS
10-A-8 ASSLT.	MON. RADC'56	C.P.1A	119° - 58'	240.5'
C.P.1A	10-A-8	29	116° - 39'	91.6'
"	"	30	164° - 09'	93.2'
"	"	31	192° - 59'	141.9'

UPD-X SURVEY DATA

MISSION NO. _____ SITUATION 1 C

EQUIPMENT MISSLES LOCATION SUPPLY SITE

∠	BS	FS	ANGLE	DISTANCE ∠ TO FS
10-A-7 SUPPLY	10-A-8 ASSLT.	C.P.2	26° - 26'	122.5'
C.P.2	10-A-7	34	119° - 30'	145.5'
"	"	33	140° - 37'	81.2'
"	"	32	203° - 00'	58.8'

UPD-X SURVEY DATA

MISSION NO. _____ SITUATION 1 C

EQUIPMENT CONVOY LOCATION COUNTY ROAD

∧	BS	FS	ANGLE	DISTANCE ∧ TO FS
10-A-6 CONVOY	10-A-5 ARTY	40	313° - 18'	118.0'
40	10-A-6	39	80° - 05' - 30"	77.6'
"	"	38	"	156.7'
"	"	37	80° - 08'	232.8'
"	"	36	80° - 06'	310.2'
"	"	35	80° - 06'	386.8'

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UPD-X SURVEY DATA

MISSION NO. _____ SITUATION 1 C

EQUIPMENT CONVOY LOCATION PLATEAU ROAD

∠	BS	FS	ANGLE	DISTANCE ∠ TO FS
MON. AZIMUTH	10-A-11 SPARE	49	75° - 42'	75.7'
"	"	47	253° - 16'	78.7'
"	"	48	338° - 38'	17.4
47	MON. AZIMUTH	46	168° - 41'	85.0'
"	"	45	169° - 49' - 30"	164.2'
45	47	44	156° - 33'	78.3'
"	"	43	156° - 30'	151.6'
"	"	42	157° - 40'	227.3'
"	"	41	160° - 00'	303.0'

UPD-X SURVEY DATA

MISSION NO. _____ SITUATION 2 C

EQUIPMENT CONVOY LOCATION HQ ROAD

∠	BS	FS	ANGLE	DISTANCE ∠ TO FS
1C14	10-A-10 SSM	3	63° - 30'	83.2'
"	"	4	80° - 22'	150.3'
"	"	5	90° - 38'	221.8'
"	"	2	352° - 28' - 30"	133.6'
"	"	1	352° - 25' - 30"	200.5'
5	1C14	6	208° - 51' - 30"	77.0'
"	"	7	208° - 40' - 30"	153.4'
7	5	8	164° - 39'	76.8'
"	"	9	163° - 45' - 30"	153.8'

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UPD-X SURVEY DATA

MISSION NO. _____ SITUATION 2 C

EQUIPMENT JEEP ARRAY LOCATION HQ FIELD

∧	BS	FS	ANGLE	DISTANCE ∧ TO FS
2C9	2C7	10	258° - 02'	85.0'
"	"	11	"	149.3'
"	"	12	258° - 08'	214.0'
"	"	13	258° - 09'	278.7'
"	"	14	231° - 13'	166.1'
14	9	15	204° - 23'	64.8'
"	"	16	204° - 26'	129.1'

UPD-X SURVEY DATA

MISSION NO. _____ SITUATION 2 C

EQUIPMENT CONVOY LOCATION SUPPLY SITE

∧	BS	FS	ANGLE	DISTANCE ∧ TO FS
C.P.2	10-A-7 SUPPLY	17	327° - 25'	62.5'
"	"	18	274° - 03'	92.8'
18	C.P.2	19	90° - 02'	76.5'
"	"	20	"	152.5'
"	"	21	"	227.4'
"	"	22	"	299.4'
"	"	23	"	373.9'
"	"	24	"	447.4'
"	"	25	"	522.1'
"	"	26	"	599.8'

UPD-X SURVEY DATA

MISSION NO. _____ SITUATION 2 C

EQUIPMENT MISSLES LOCATION SUPPLY

∠	BS	FS	ANGLE	DISTANCE ∠ TO FS
1C34	C.P.2	28	217° - 09'	128.2'
28	1C34	29	100° - 46'	96.2'
"	"	27	229° - 12'	78.1'

UPD-X SURVEY DATA

MISSION NO. _____ SITUATION 2C

EQUIPMENT ARMOR LOCATION ROCK PILE

⌅	BS	FS	ANGLE	DISTANCE ⌅ TO FS
1C18	C.P.1	30	149° - 09' - 30"	94.1'
30	1C18	31	87° - 11'	126.2'
"	"	32	"	207.5'
"	"	33	"	288.5'
"	"	34	"	368.0'
"	"	35	"	444.2'
"	"	36	"	528.2'
"	"	37	"	624.2'
"	"	38	"	708.6'
32	30	39	129° - 27'	120.5'

UPD-X SURVEY DATA

MISSION NO. _____ SITUATION 3 C

EQUIPMENT CONVOY LOCATION AAA SITE

∧	BS	FS	ANGLE	DISTANCE ∧ TO FS
10-A-2 AAA	10-A-1 SAM	42	27° - 17' - 30"	250.8'
42	10-A-2	43	177° - 50' - 30"	218.4'
"	"	44	" "	355.6'
"	"	45	" "	466.9'
45	42	46	227° - 42'	172.2'
"	"	47	"	278.7'
42	10-A-2	41	313° - 00'	107.8'
"	"	40	"	215.8'
"	"	39	"	327.3'
47	45	48	123° - 01'	114.3'
48	47	49	126° - 52'	232.3'

UPD-X SURVEY DATA

MISSION NO. _____ SITUATION 3 C

EQUIPMENT ARMOR LOCATION MOUND

∧	BS	FS	ANGLE	DISTANCE ∧ TO FS
2C5	1C14	33	105°-35'	88.5'
33	2C5	32	140°-33'	119.2'
33	2C5	35	173°-52'	159.3'
33	2C5	34	218°-33'	88.0'

UPD-X SURVEY DATA

MISSION NO. _____ SITUATION 3 C

EQUIPMENT ARMOR LOCATION NEAR MOUND

∧	BS	FS	ANGLE	DISTANCE ∧ TO FS
2C5	1C14	31	293°-43'	120.0'
2C5	1C14	29	309°-14'	198.2'
2C5	1C14	30	331°-30'	148.8'

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UPD-X SURVEY DATA

MISSION NO. _____ SITUATION 3C

EQUIPMENT ARMOR LOCATION HONEST JOHN

∧	BS	FS	ANGLE	DISTANCE ∧ TO FS
10-A-11	AZIMUTH MON.	26	03°-25'	159.2'
10-A-11	"	27	26°-30'	64.7'
10-A-11	"	28	37°-43'-30"	164.3'

UPD-X SURVEY DATA

MISSION NO. _____ SITUATION 3 C

EQUIPMENT CONVOY LOCATION CRANE ROAD

∧	BS	FS	ANGLE	DISTANCE ∧ TO FS
MON.	HONEST J. 10-A-11	22	43°-59'	63.8'
22	MON	23	139°-57'	93.3'
22	MON	24	139°-57'	191.8'
22	MON	25	139°-57'	286.9'
22	MON	21	252°-51'	124.1'
22	MON	20	252°-51'	207.0'
20	22	19	170°-41'	135.0'
20	22	18	170°-41'	222.6'
20	22	17	170°-41'	317.1'
20	22	16	170°-41'	410.0'

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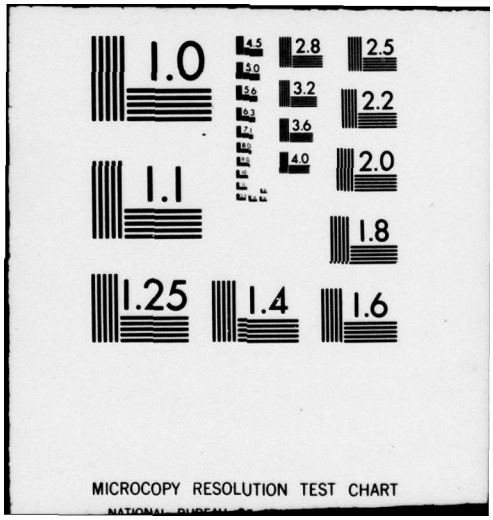
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UPD-X SURVEY DATA

MISSION NO. _____ SITUATION 3 C

EQUIPMENT JEEPS LOCATION SUPPLY

∧	BS	FS	ANGLE	DISTANCE ∧ TO FS
SUPPLY 10-A-7	CP# 2	12	170°-11'	102.7'
"	"	13	223°-38'	106.0'
"	"	14	277°-21'-30"	120.8'
"	"	15	311°-32'-30"	115.5'

UPD-X SURVEY DATA

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MISSION NO. _____ SITUATION 3 C

EQUIPMENT ARTILLERY LOCATION ENTRANCE FIELD WEST

∠	BS	FS	ANGLE	DISTANCE ∠ TO FS
CONVOY 10-A-6	ARTILLERY 10-A-5	CP# 3	212°-12	227.8'
CP#3	10-A-6	38	88°-42	136.9'
"	"	37	88°-42	226.8'
"	"	36	88°-42'	322.4'

UPD-X SURVEY DATA

MISSION NO. _____ SITUATION 3 C AND 2 C

EQUIPMENT CP# 4 LOCATION ENTRANCE FLD. EAST

∧	BS	FS	ANGLE	DISTANCE ∧ TO FS
MON	HON. JOHN 10-A-11	CP# 4	179°-10'-30"	785.2'
CP# 4	MON	3C11	165°-09'	320.5'

UPD-X SURVEY DATA

MISSION NO. _____ SITUATION 2 C

EQUIPMENT ARTILLERY LOCATION COUNTY ROAD

∠	BS	FS	ANGLE	DISTANCE ∠ TO FS
CP# 4	MON	41	240°-55'	242.2'
41	CP# 4	42	21°-49'	84.6'
41	CP# 4	40	246°-48'	95.5'

UPD-X SURVEY DATA

MISSION NO. _____ SITUATION 3 C

EQUIPMENT MIXED ARRAY LOCATION COUNTY ROAD

⍲	BS	FS	ANGLE	DISTANCE ⍲ TO FS
11	CP#4	4	170°-32'	101.3'
11	"	10	269°-55'	98.3'
11	"	9	269°-55'	193.0'
11	"	8	269°-55'	289.7'
05	11	1	179°-47'	79.5'
04	11	5	279°-06'	109.7'
04	11	6	279°-06'	217.9'
04	11	7	279°-06'	317.6'
01	4	2	277°-51'	118.9'
01	4	3	277°-51'	238.1'

UPD-X SURVEY DATA

MISSION NO. _____ SITUATION 2 C

EQUIPMENT JEEPS LOCATION COUNTY ROAD

∠	BS	FS	ANGLE	DISTANCE ∠ TO FS
3 C 1	3C4	47	110°-39'	341.7'
47	3C1	43	193°-06	74.0'
47	3C1	48	291°-00'	66.5'
47	3C1	49	291°-00'	135.5'
43	47	44	270°-33'	67.8'
43	47	45	270°-33'	131.4'
43	47	46	270°-33'	196.5'

UPD-X SURVEY DATA

MISSION NO. _____ SITUATION STATIC TARGETS

EQUIPMENT ALL LOCATION SEE BELOW

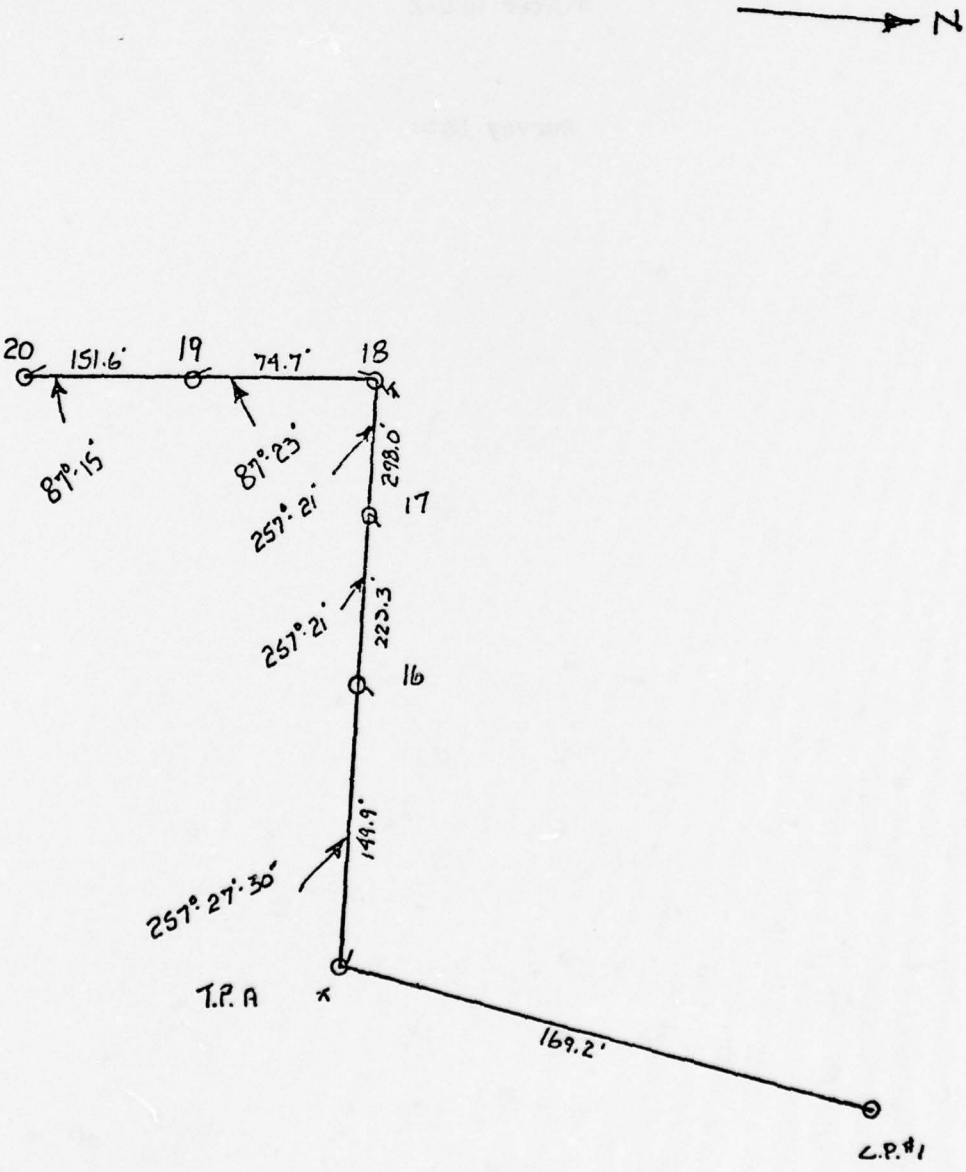
↑	BS	FS	ANGLE	DISTANCE ↑ TO FS	
1C9	1C5	4	167° - 00'	129.0'	SAM SITE
1C1	10-A-1 SAM	5	05° - 35'	172.0'	"
"	"	6	09° - 54'	135.0'	"
"	"	3	107° - 14'	162.0'	"
"	"	2	181° - 56'	115.0'	"
"	"	19	258° - 00'	197.0'	"
"	"	7	352° - 17'	112.0'	"
10-A-2 AAA	10-A-1 SAM	12	100° - 30'	86.0'	AAA
"	"	11	157° - 45'	"	"
"	"	10	218° - 45'	"	"
"	"	9	339° - 10'	"	"
"	"	8	"	173.0'	"
10-A-12 ARMOR	10-A-3 MORTAR	13	178° - 25'	80.2'	ARMOR
10-A-8 ASSLT.	MON RADC'56	19	121° - 50'	180.0'	ASSAULT ENG.
"	"	20	129° - 20'	199.0'	"
"	"	18	286° - 40'	122.5'	"
10-A-5 ARTY	10-A-6 CONVOY	15	120° - 17'	149.0'	ARTILLERY
10-A-8 ASSLT.	MON. RADC'56	C.P.5	130° - 49' - 30"	293.6'	JEEP ARRAY
C.P. 5	10-A-8	25	05° - 24'	188.7'	" "
"	"	24	65° - 24'	"	" "
"	"	23	95° - 24'	"	" "
"	"	22	125° - 24'	"	" "
"	"	21	155° - 24'	"	" "
"	"	26	235° - 24'	155.8'	" "

APPENDIX A

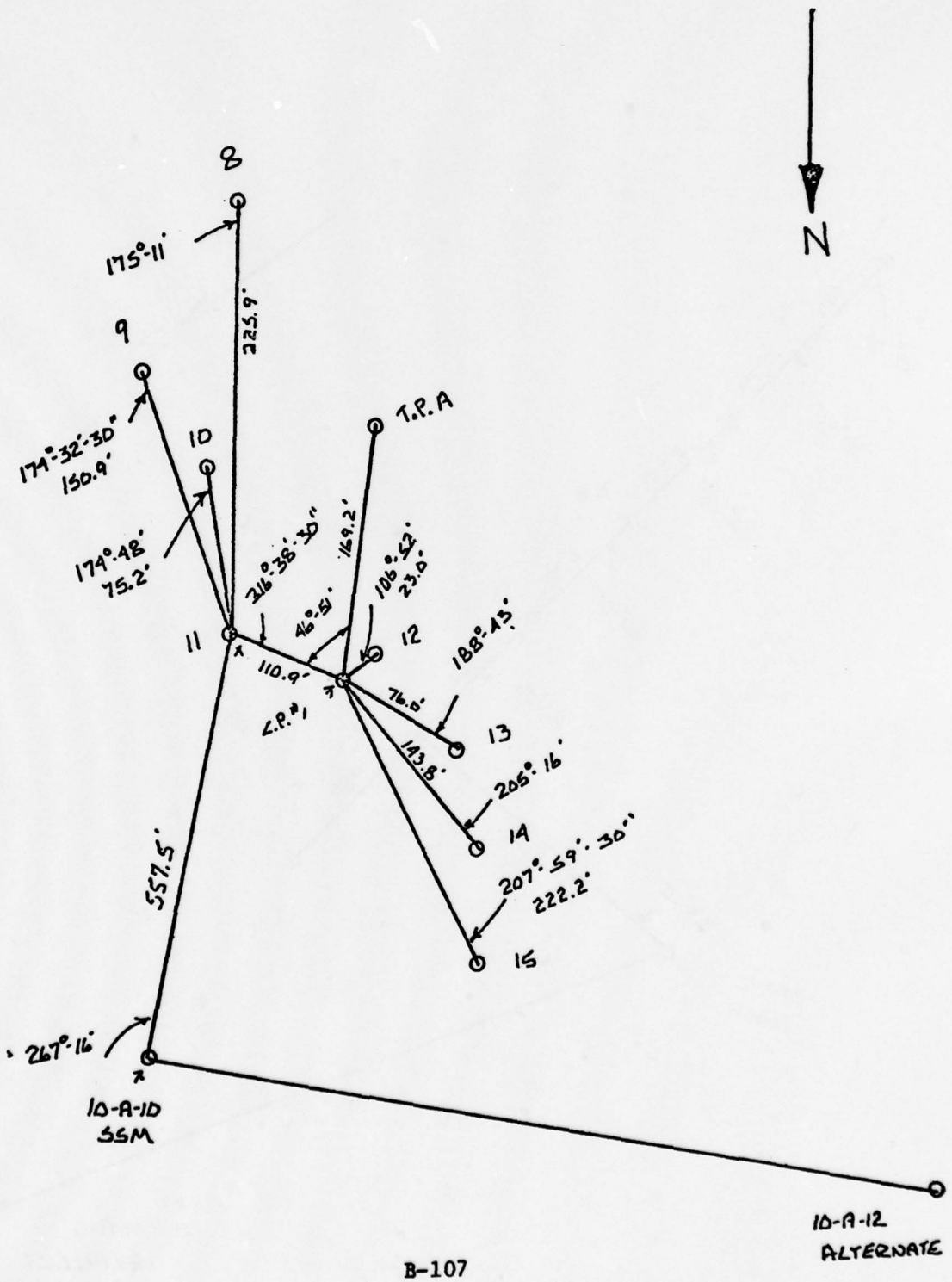
Winter UPD-X

Survey Data

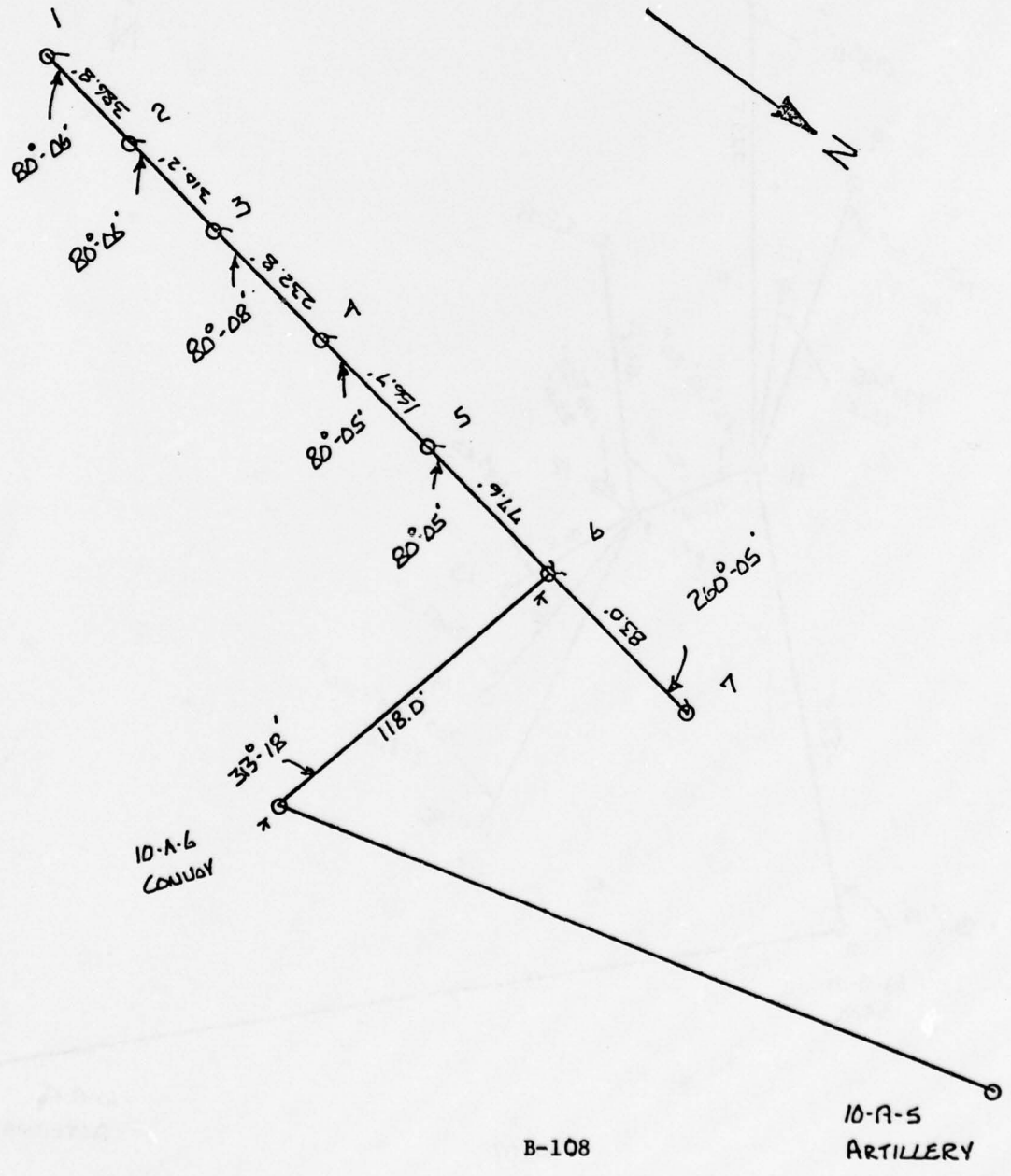
UPD-X Field Survey Data - Situation Winter 1(4a) Armor Vee Formation (Not to Scale)



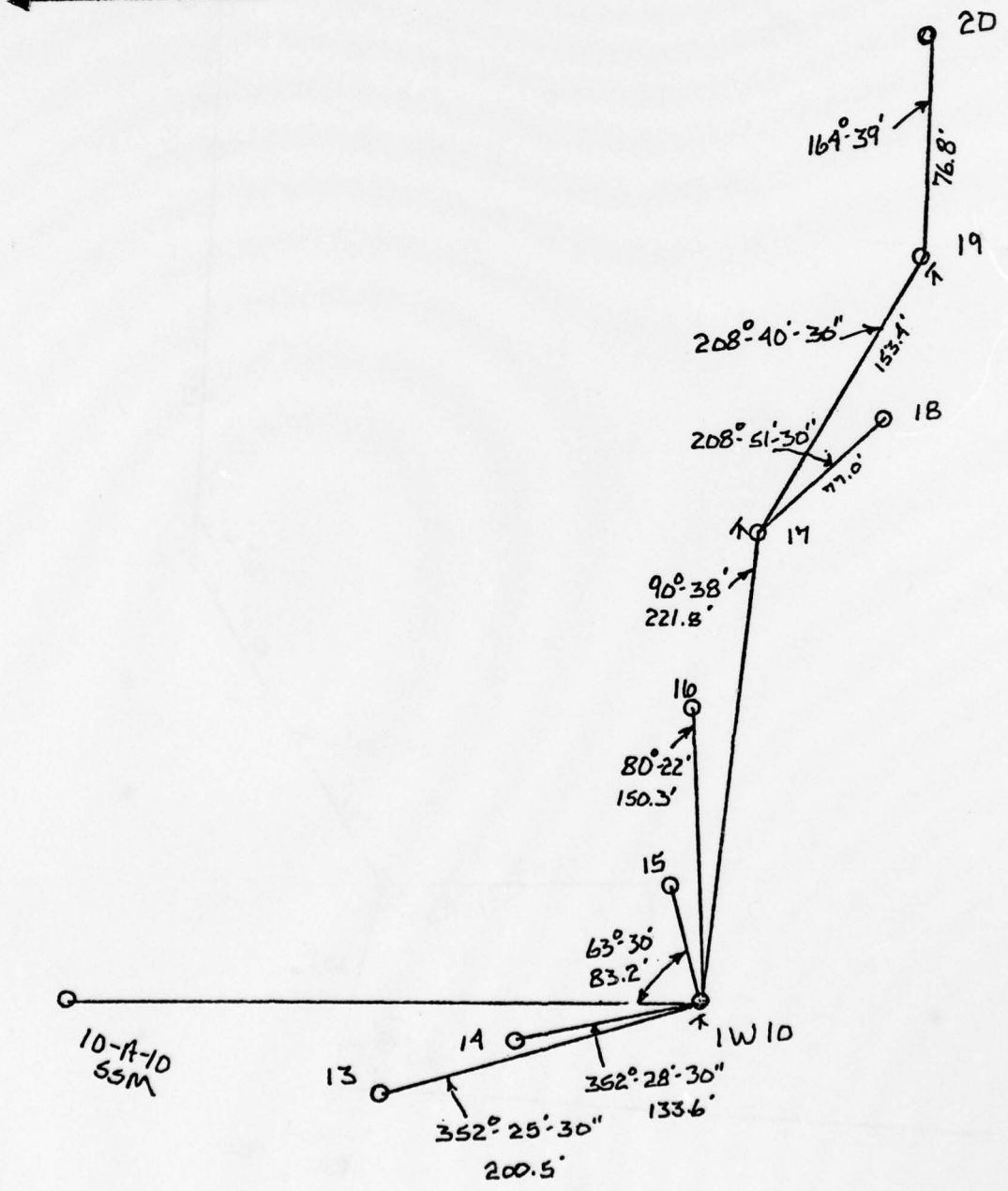
UPD-X Field Survey Data - Situation Winter 1(4a) Rock Pile Convoy (Not to Scale)



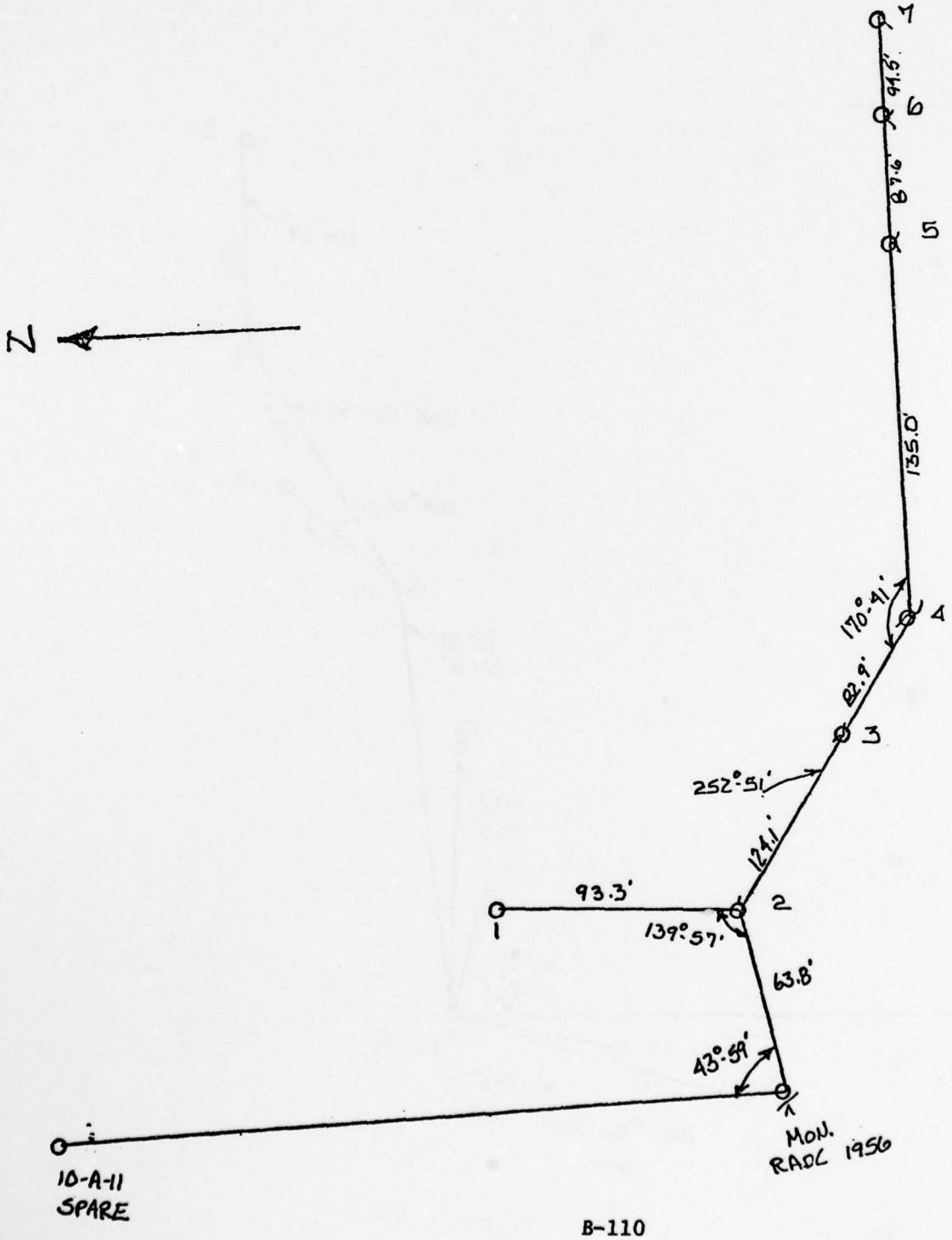
UPD-X Field Survey Data - Situation Winter 1(4a) Convoy at County Road (Not to Scale)



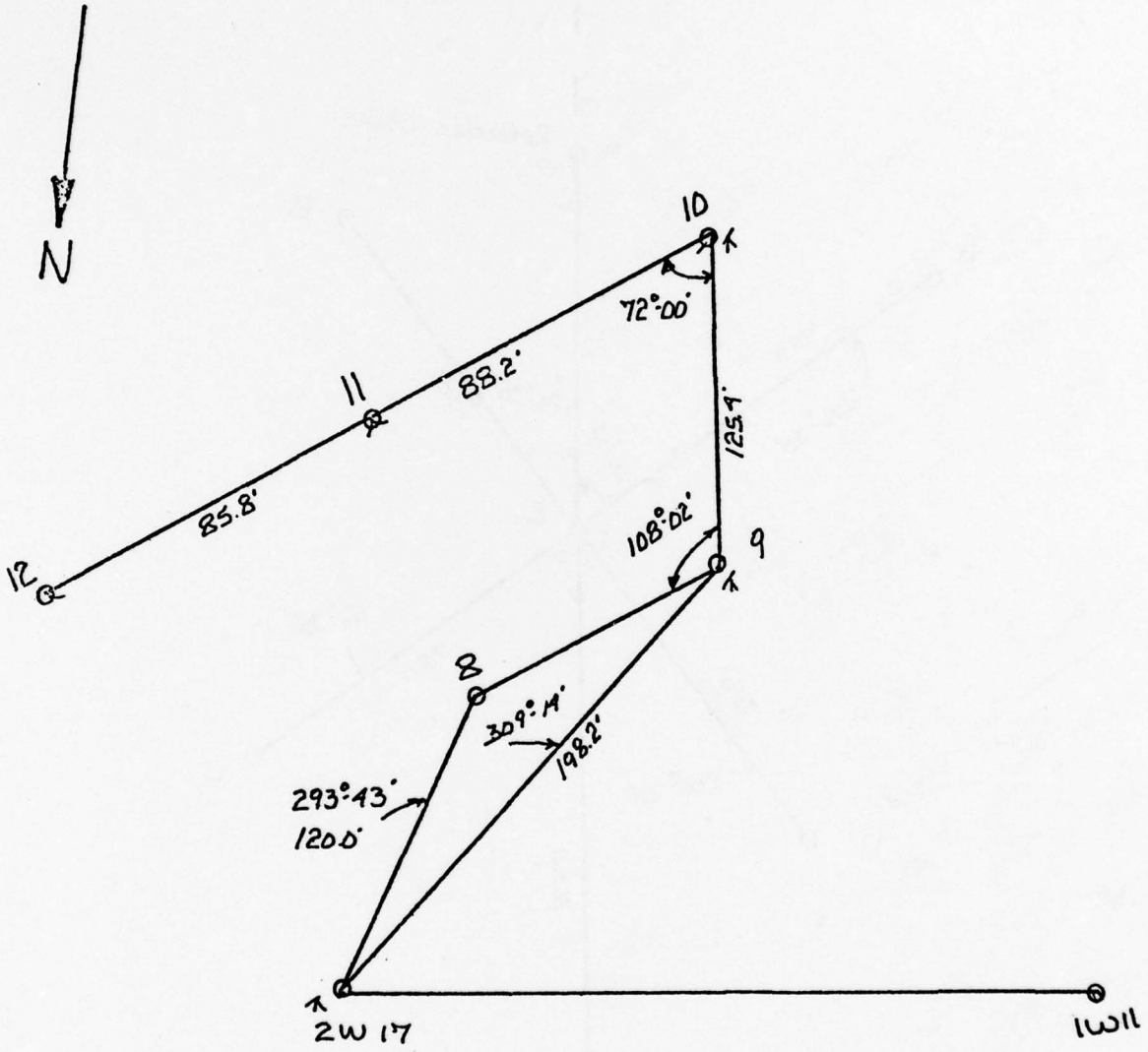
UPD-X WINTER TEST 5-A HEADQUARTERS CONVOY (Not to scale)



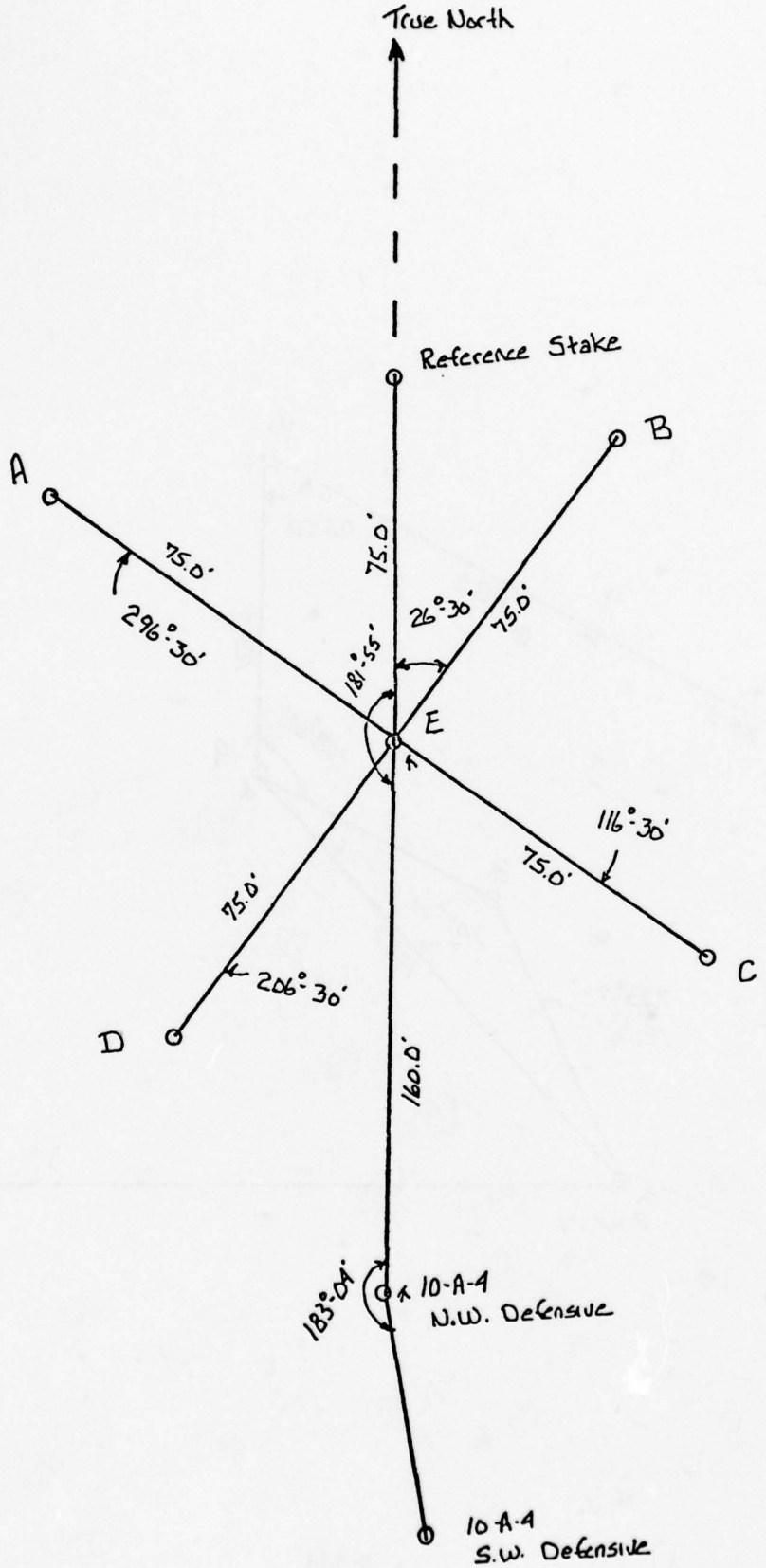
UPD-X WINTER TEST 5-A CRANE ROAD CONVOY (Not to scale)



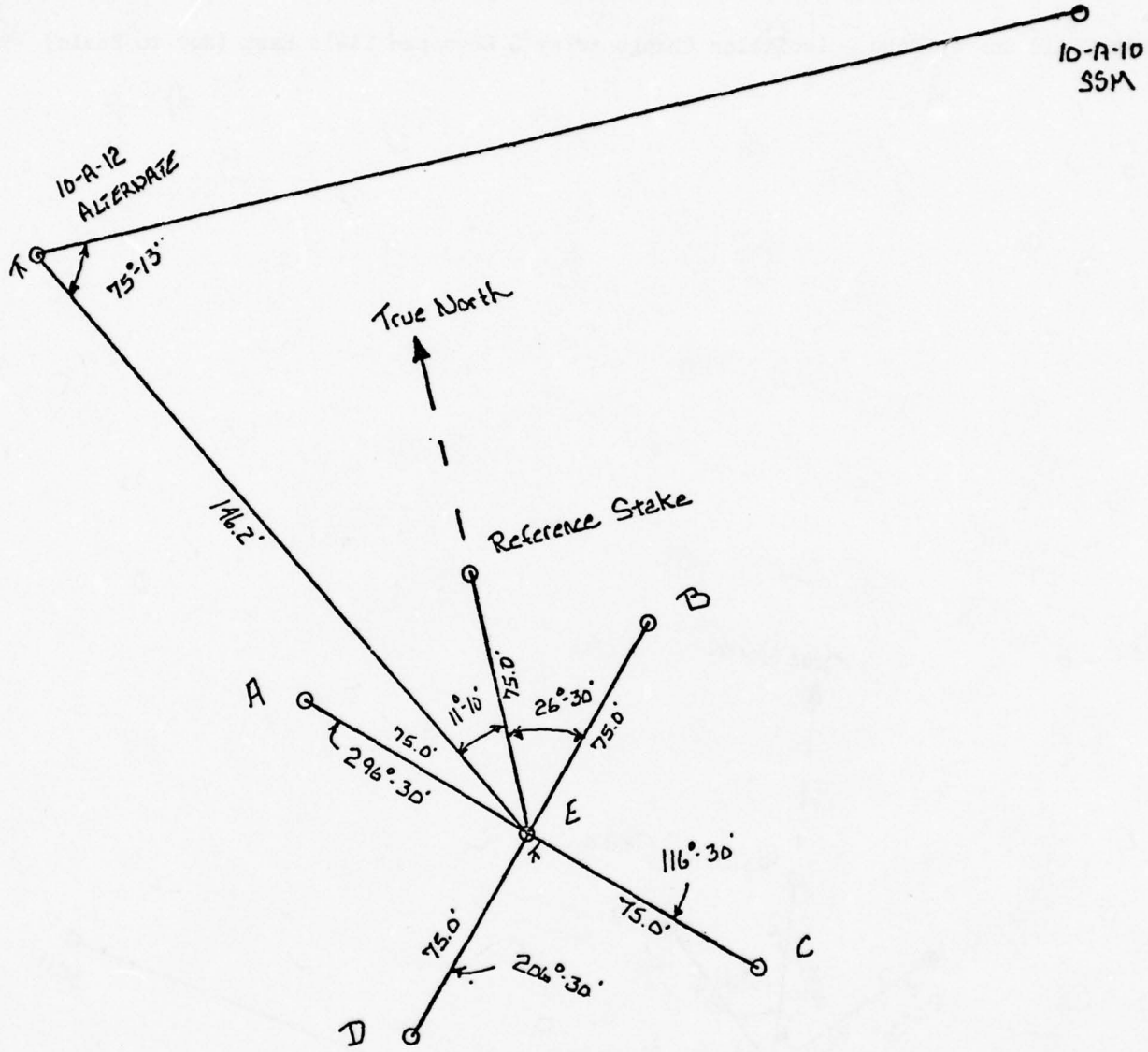
UPD-X WINTER TEST 5-A ARMOR ARRAY NEAR MOUND (Not to scale)



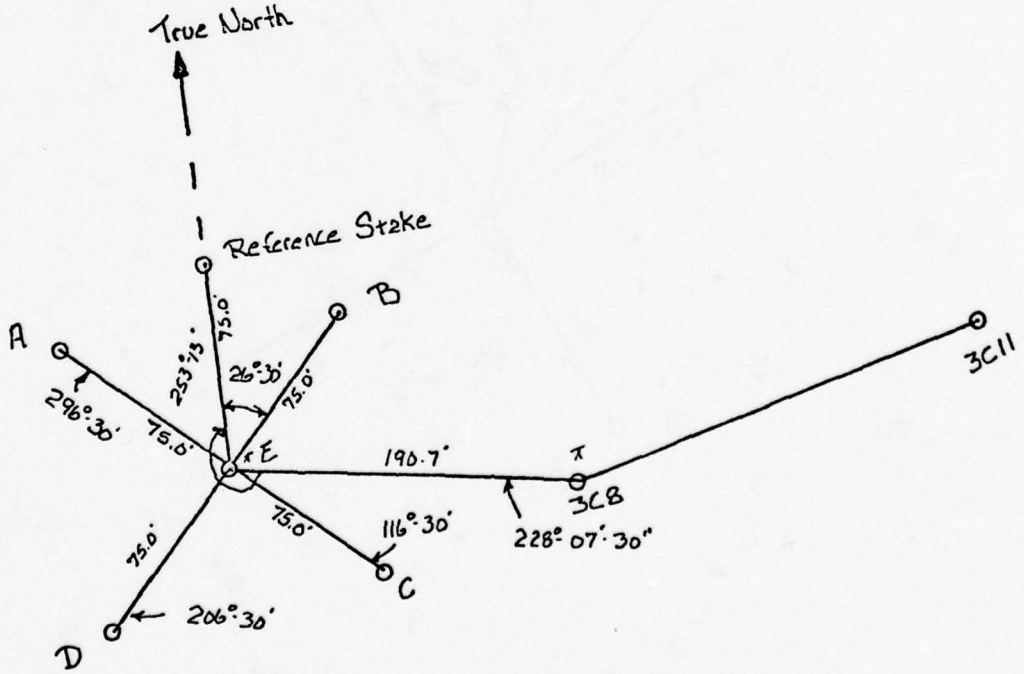
UPD-X Field Survey Data - Isolation Change Array-1 Minefield (Not to Scale)



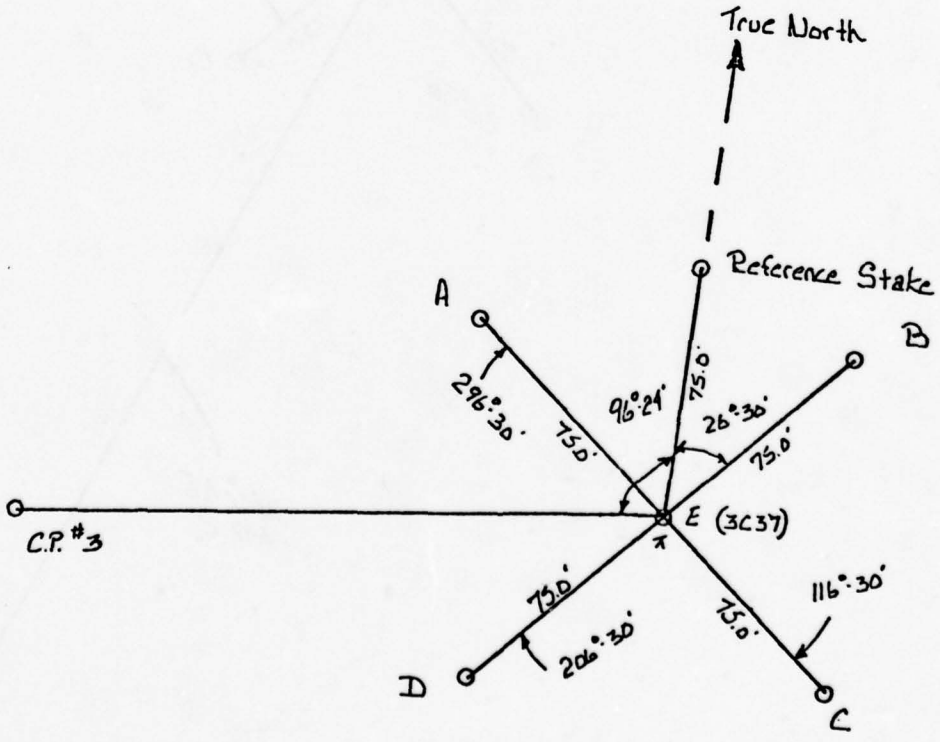
UPD-X Field Survey Data - Isolation Change Array-2 Alternate Armor (Not to Scale)



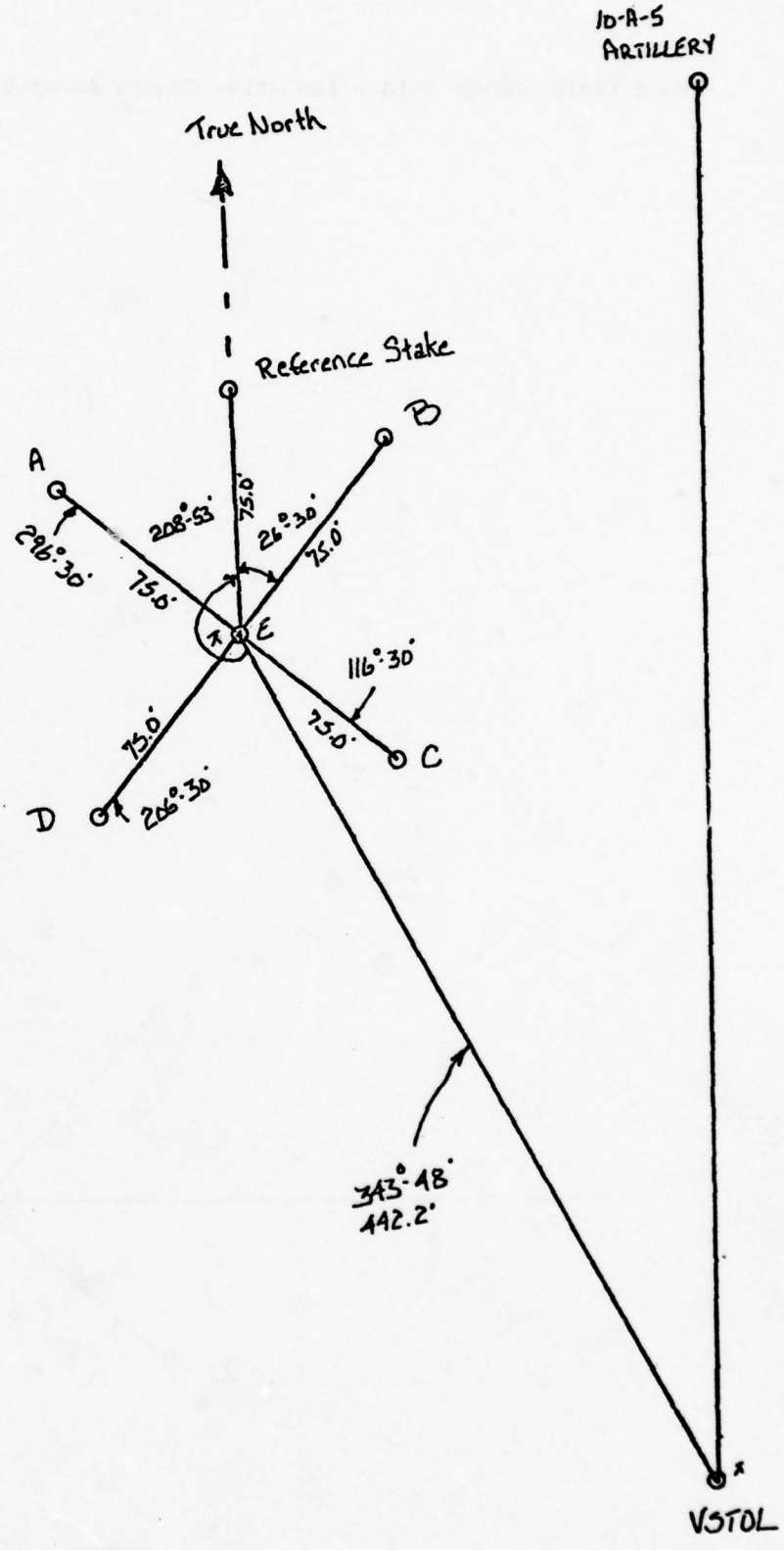
UPD-X Field Survey Data - Isolation Change Array-3 Entrance Field East (Not to Scale)



UPD-X Field Survey Data - Isolation Change Array-4 Entrance Field West (Not to Scale)

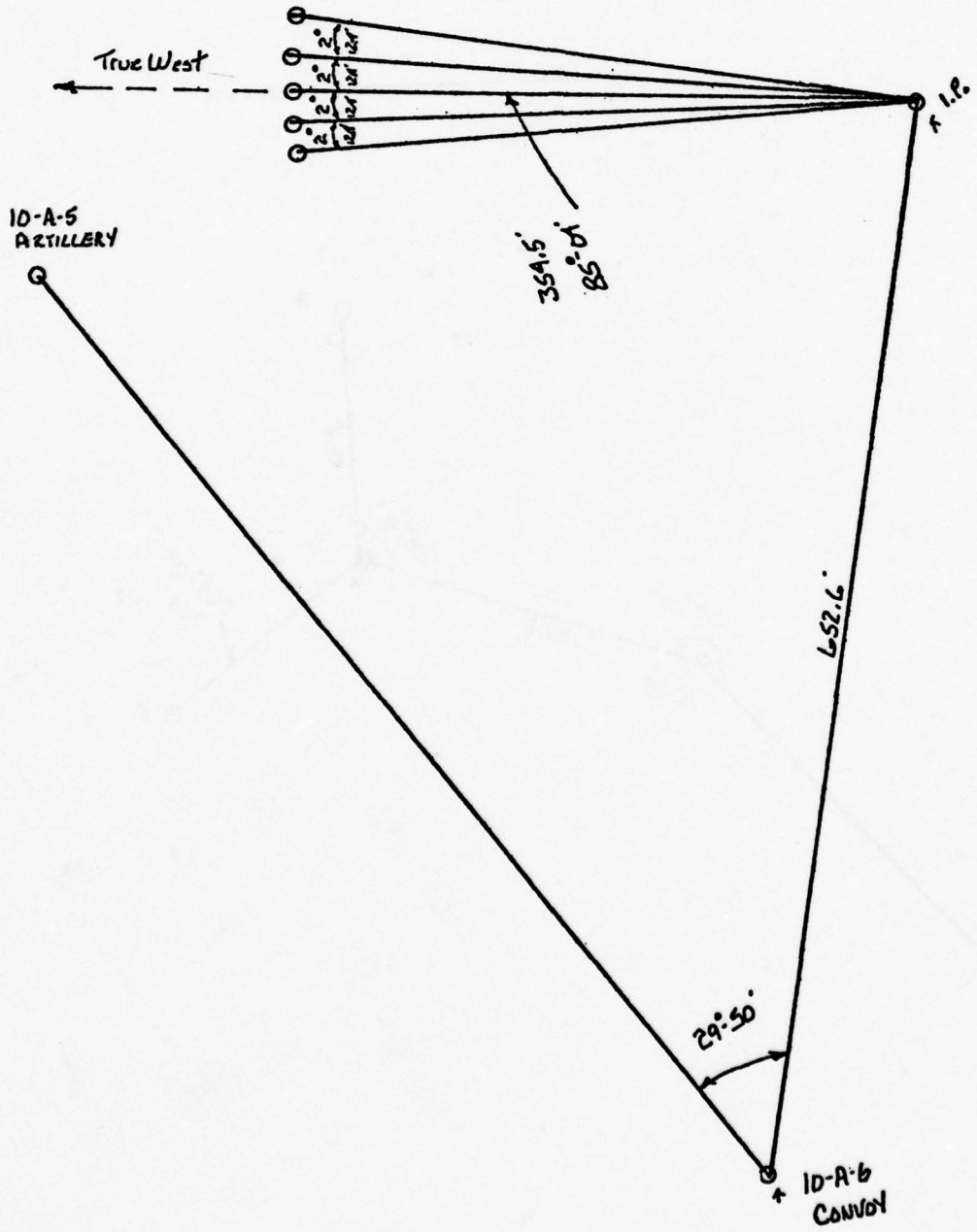


UPD-X Field Survey Data - Isolation Change Array-5 240 Pad (Not to Scale)

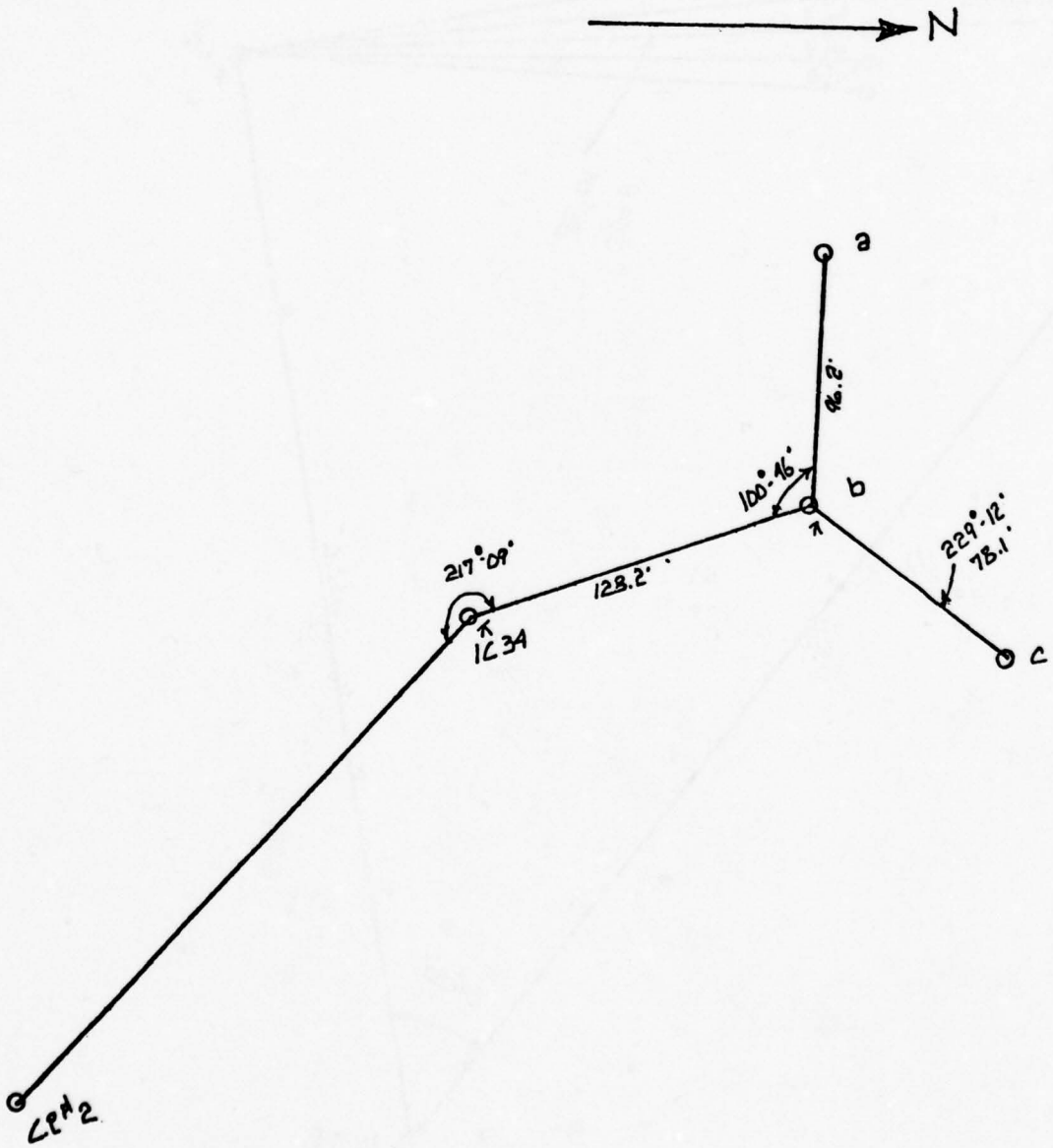


UPD-X FIELD SURVEY DATA- DIHEDRAL REFLECTOR ARRAY

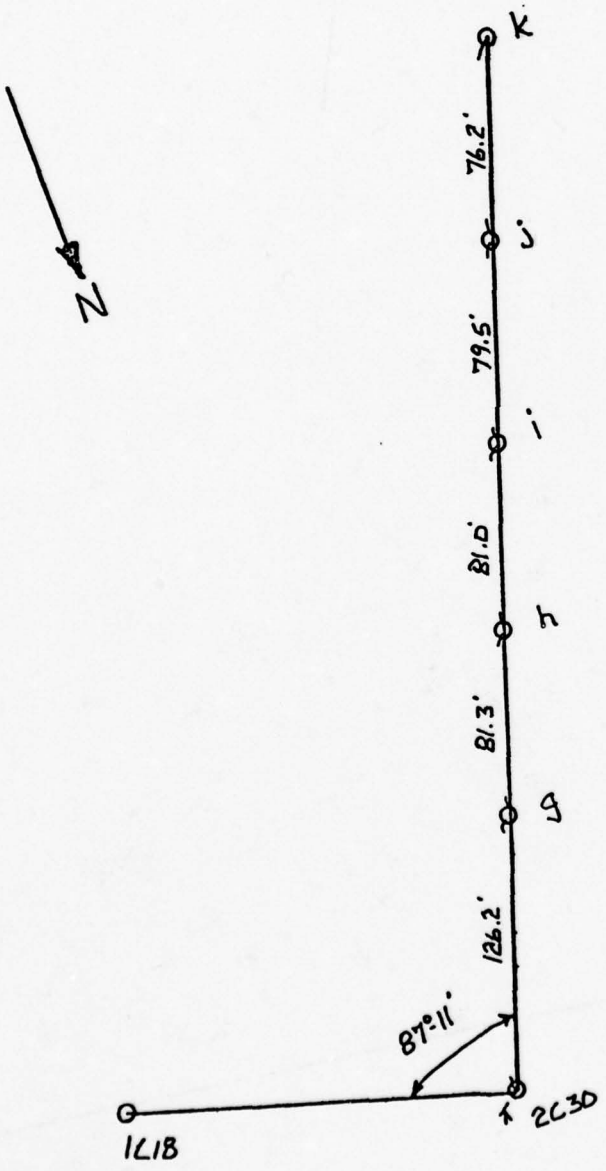
(Not to scale)



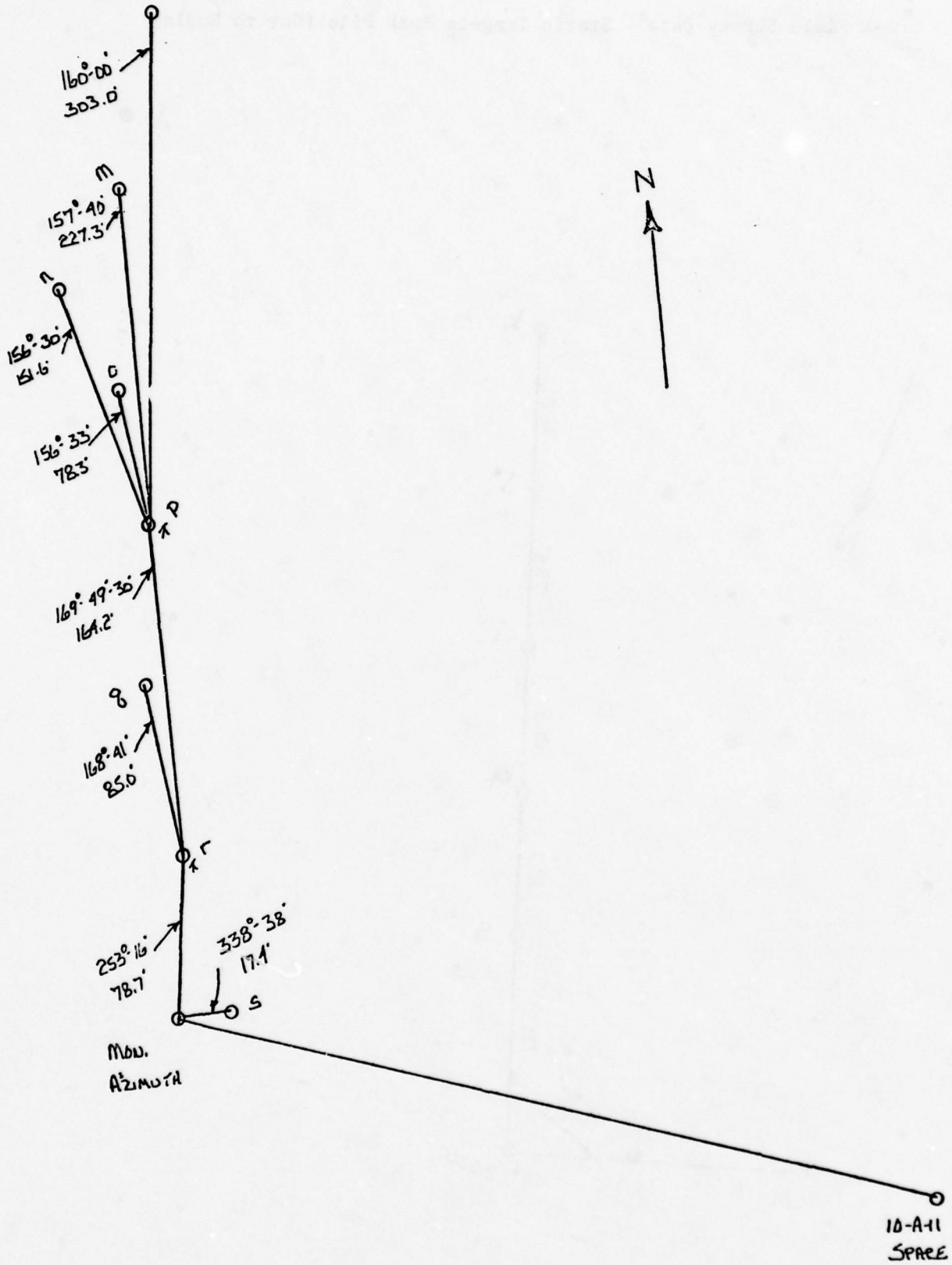
UPD-X Field Survey Data - Static Targets Supply Field (Not to Scale)



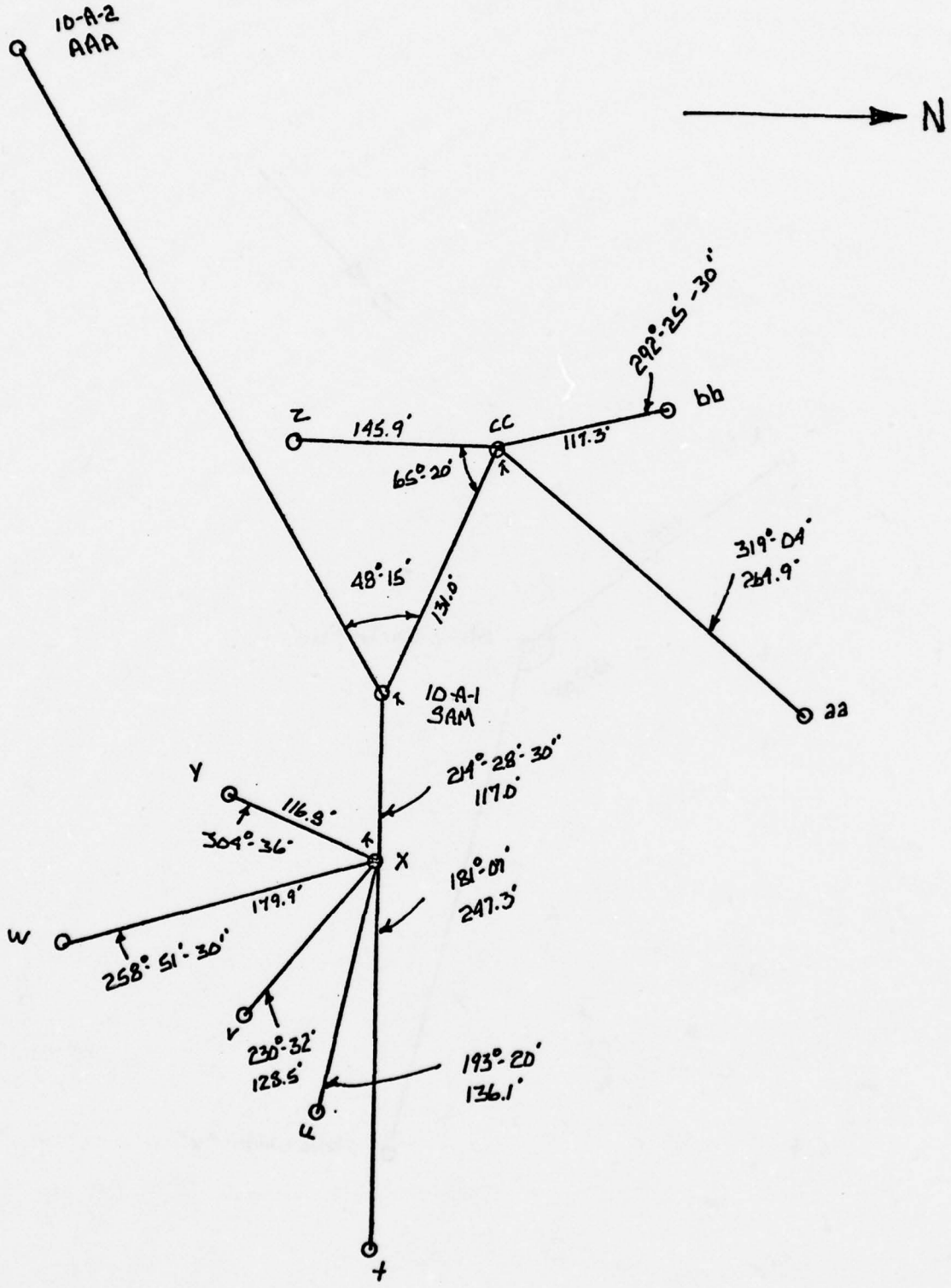
UPD-X Field Survey Data - Static Targets Rock Pile (Not to Scale)



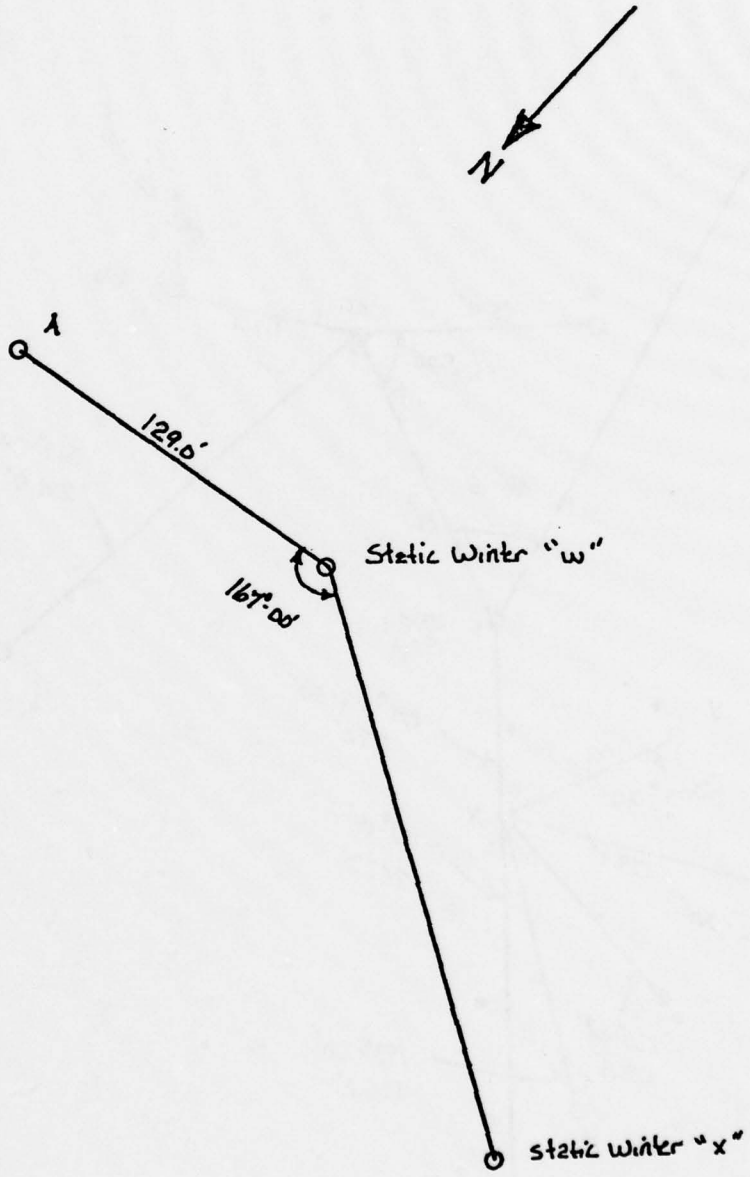
UPD-X Field Survey Data - Static Targets Plateau Road Convoy (Not to Scale)



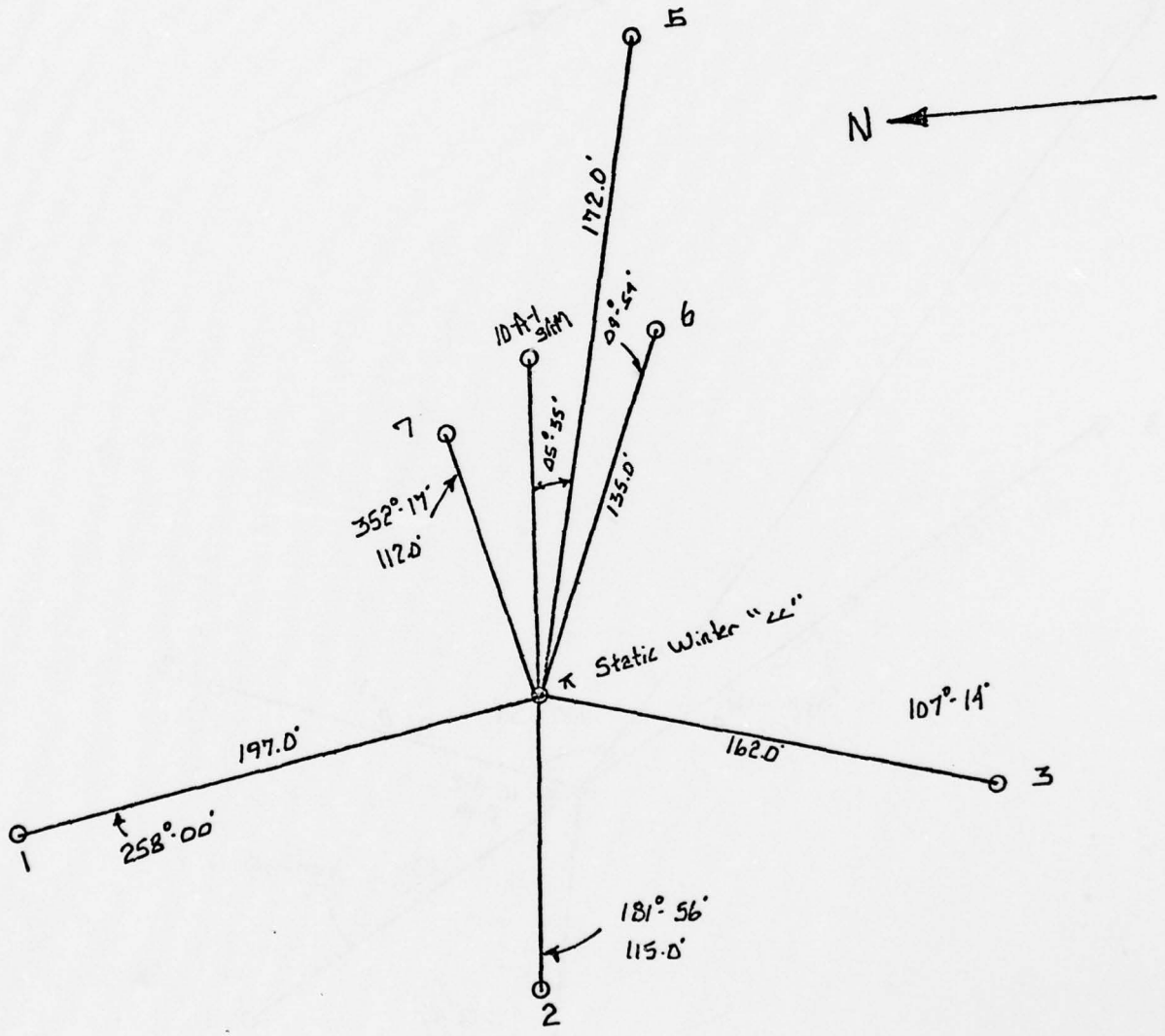
UPD-X Field Survey Data - Static Targets Sam Site (Not to Scale)



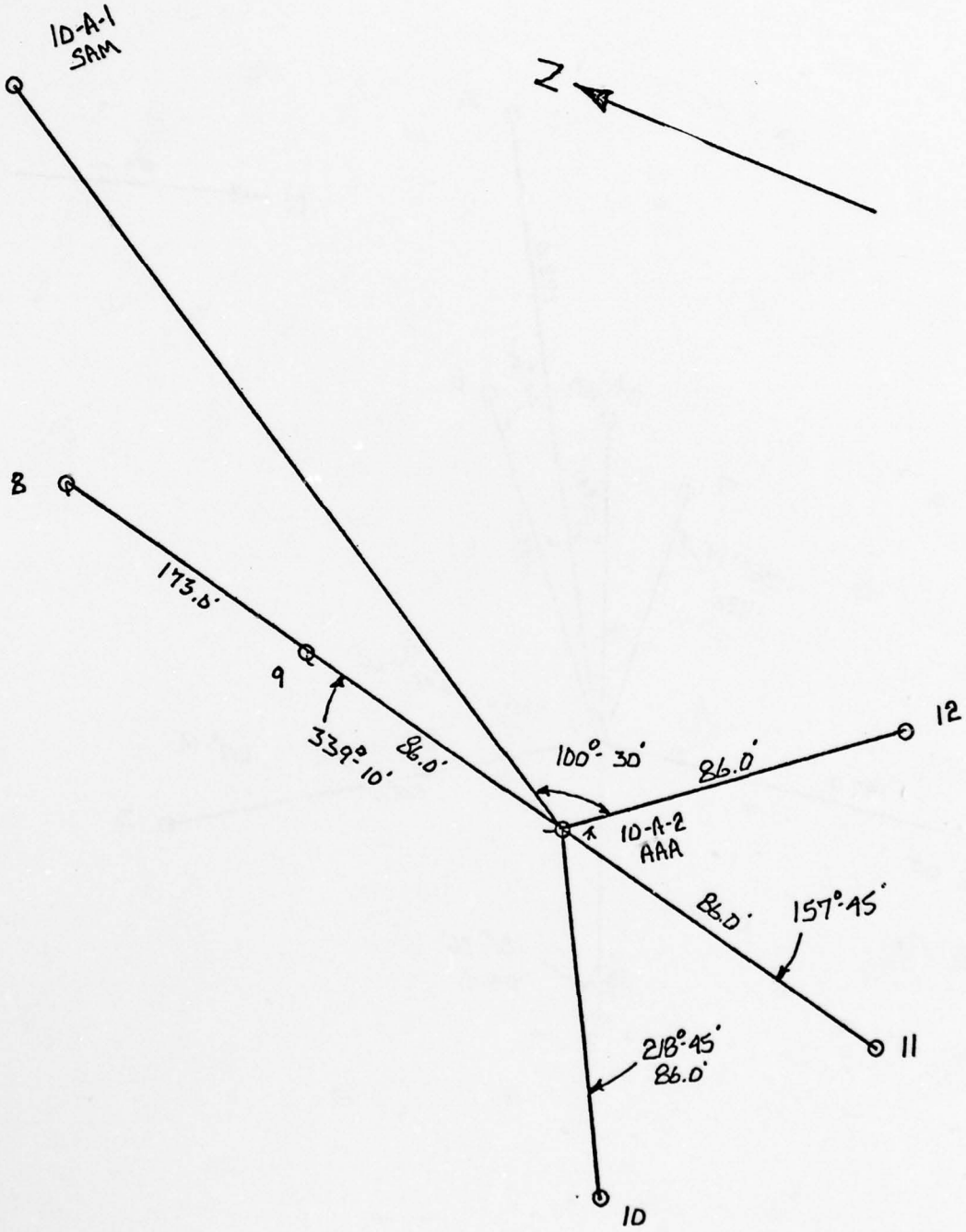
UPD-X Field Survey Data - Static Targets Sam Site (Not to Scale)



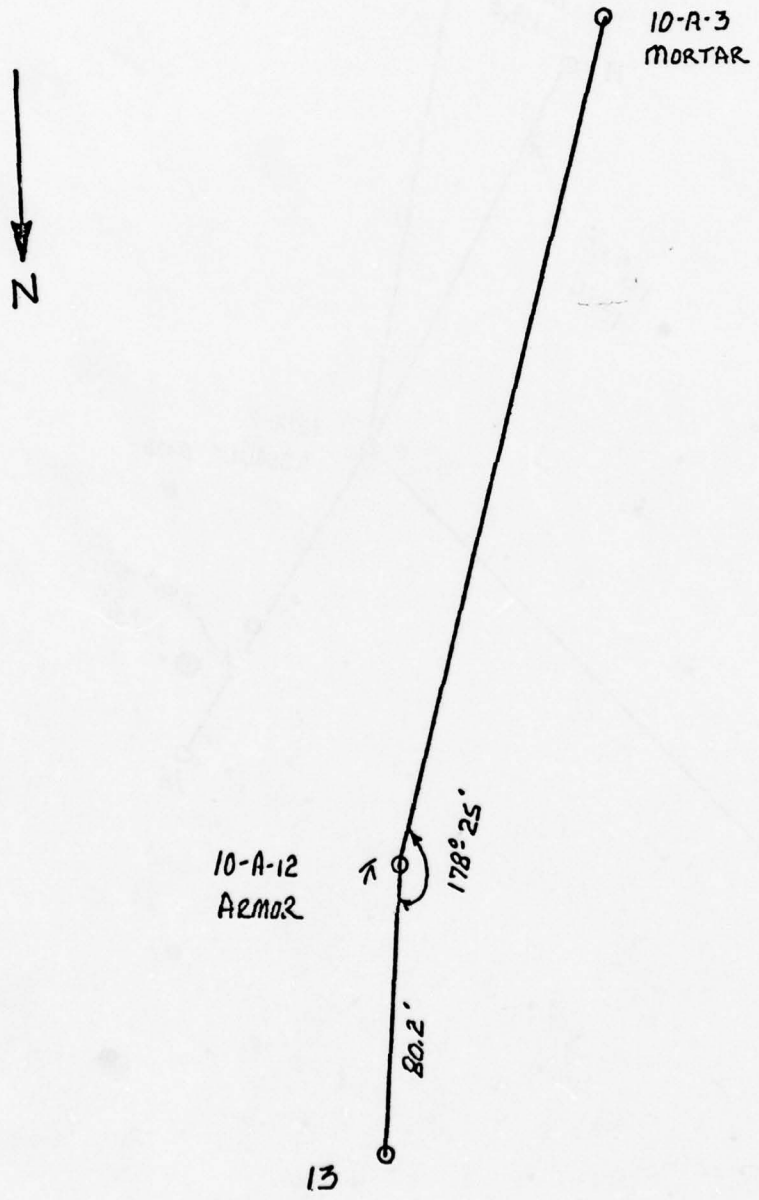
UPD-X Field Survey Data - Static Targets Sam Site (Not to Scale)



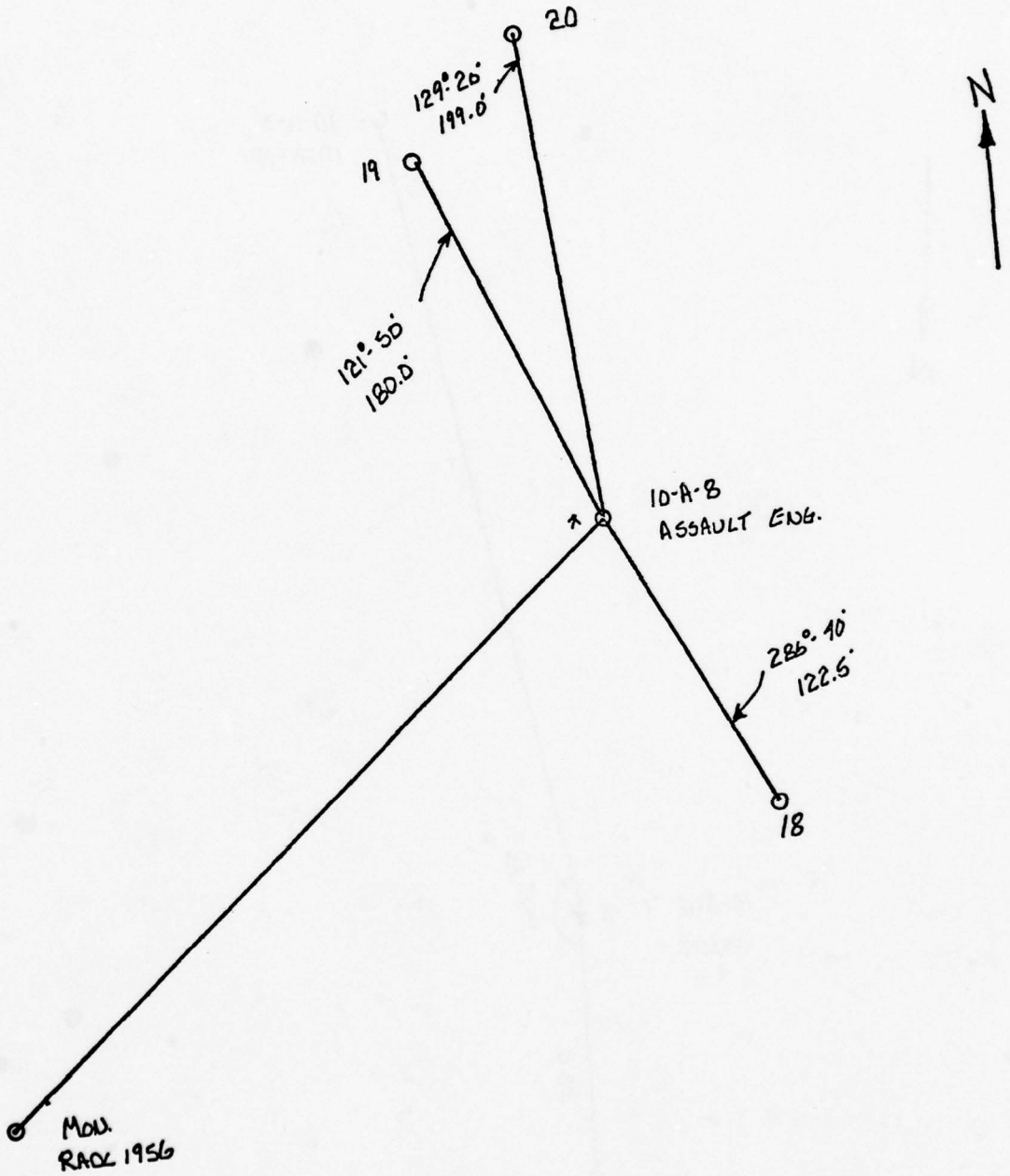
UPD-X Field Survey Data - Static Targets AAA Site (Not to Scale)



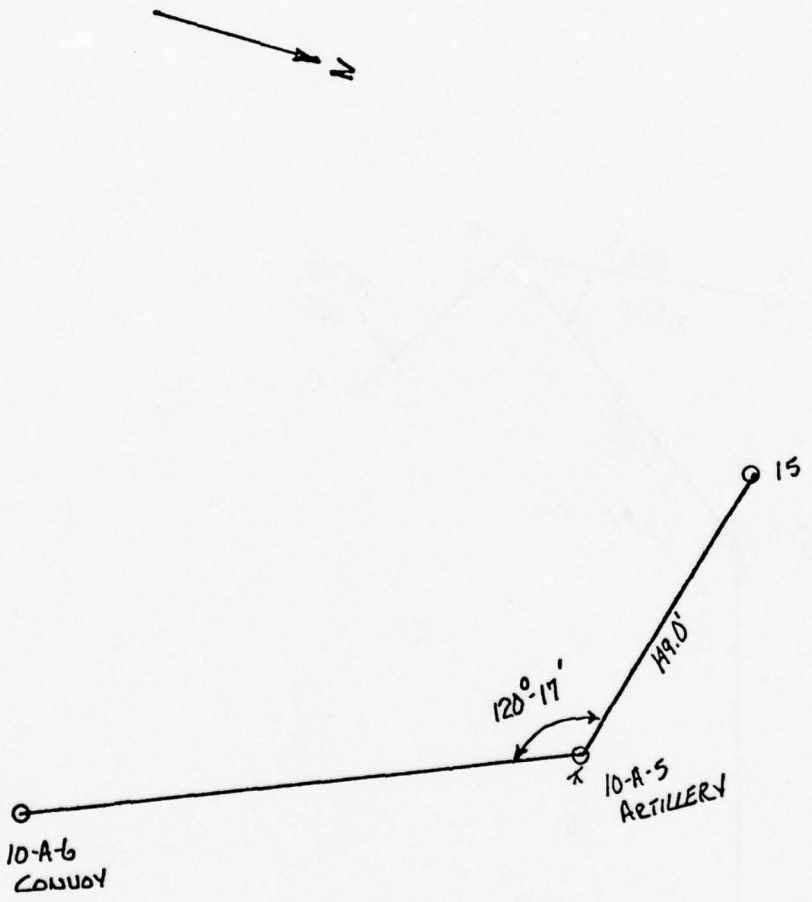
UPD-X Field Survey Data - Static Targets Armor Site (Not to Scale)



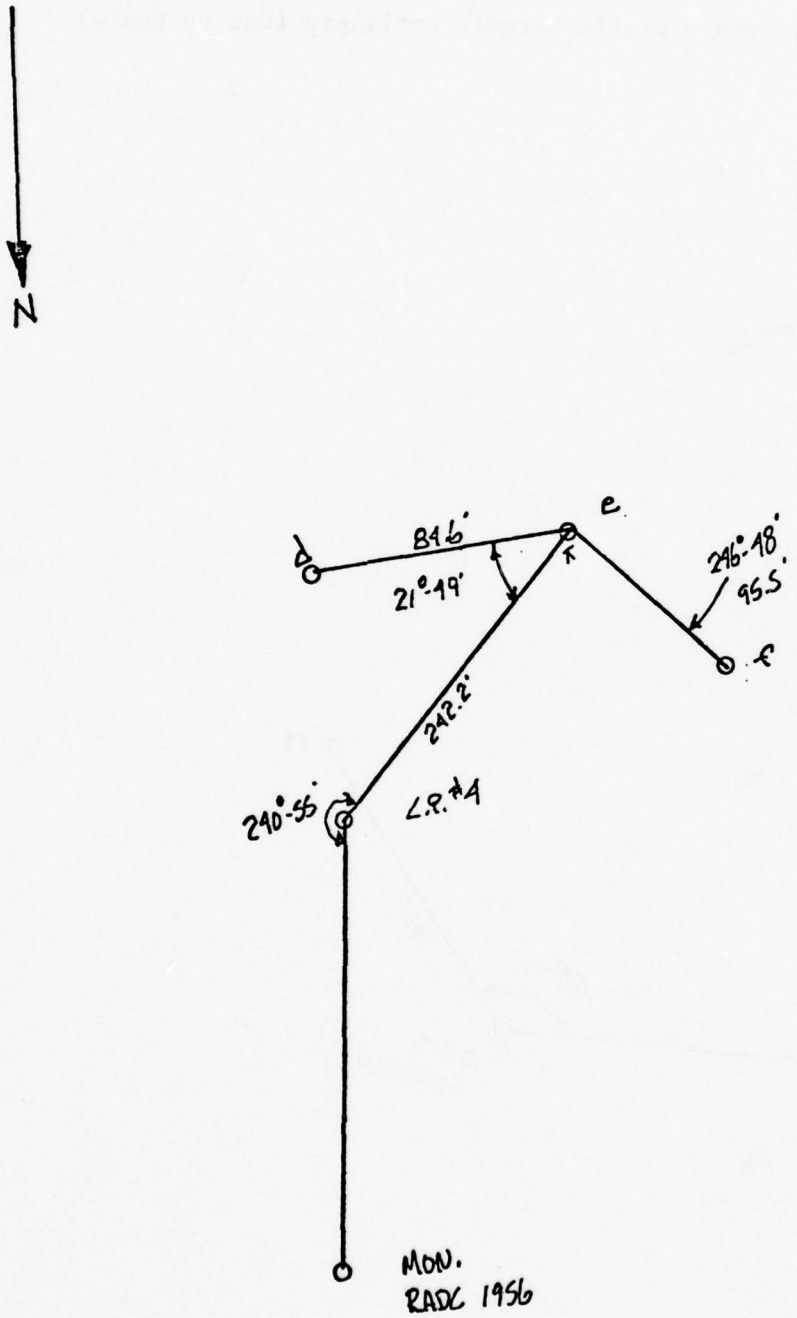
UPD-X Field Survey Data - Static Targets Assault Engineers (Not to Scale)



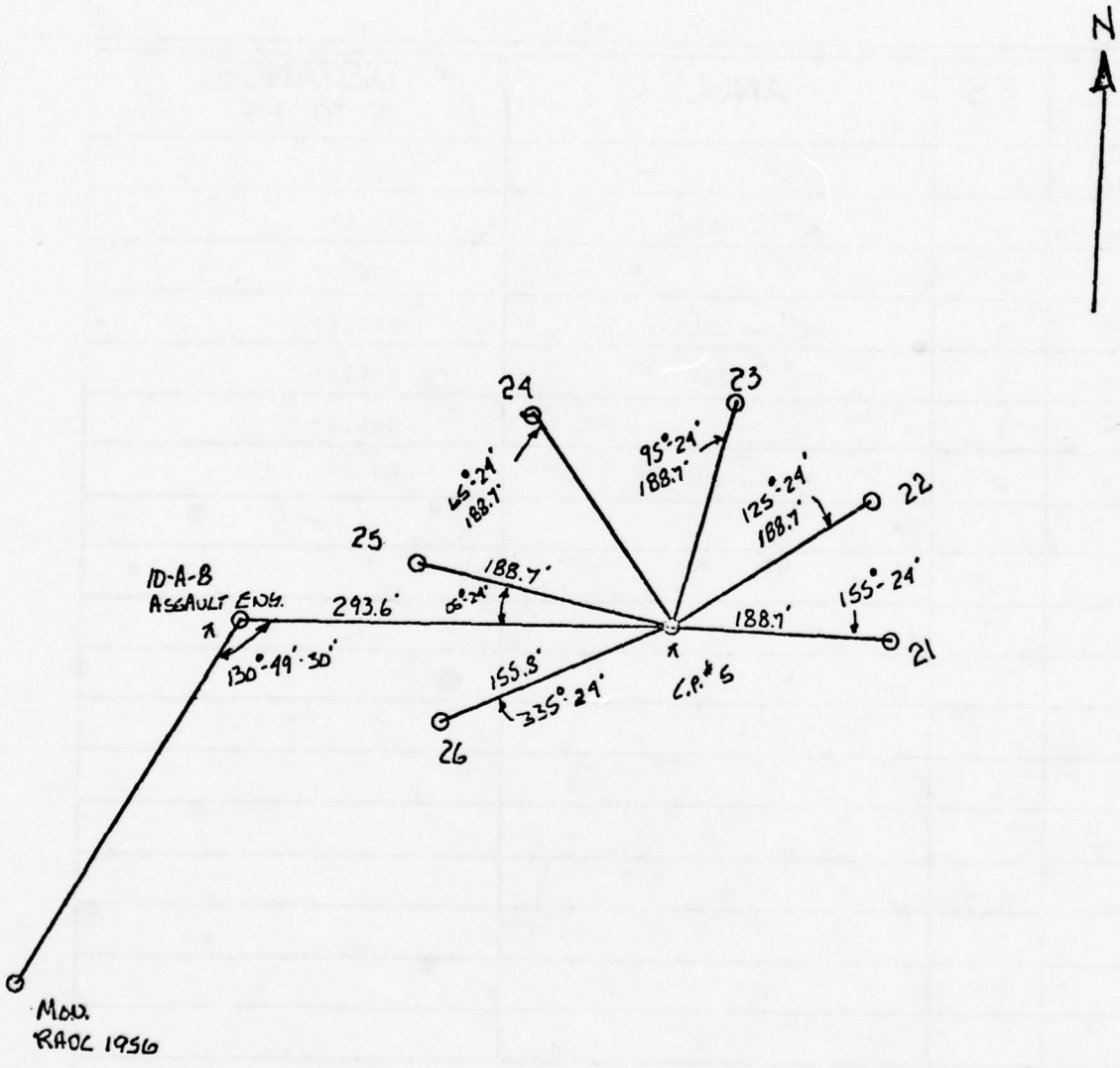
UPD-X Field Survey Data - Static Targets Artillery (Not to Scale)



UPD-X Field Survey Data - Static Targets Missles at Entrance Field (Not to Scale)



UPD-X Field Survey Data - Static Targets Jeep Array (Not to Scale)



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UPD-X SURVEY DATA

MISSION NO. _____ SITUATION WINTER 1

EQUIPMENT CONVOY LOCATION COUNTY ROAD

⌅	BS	FS	ANGLE	DISTANCE ⌅ TO FS
10-A-6 CONVOY	10-A-5 ARTY	6	313° - 18'	118.0'
6	10-A-6	5	80° - 05'	77.6'
"	"	4	"	156.7'
"	"	3	80° - 08'	232.8'
"	"	2	80° - 06'	310.2'
"	"	1	"	386.8'
"	"	7	260° - 05'	83.0'

UPD-X SURVEY DATA

MISSION NO. _____ SITUATION WINTER 1

EQUIPMENT CONVOY LOCATION ROCK PILE

∠	BS	FS	ANGLE	DISTANCE ∠ TO FS
10-A-10 SSM	10-A-12 ALT.	11	267° - 16'	557.5'
11	10-A-10	9	174° - 32' - 30"	150.9'
"	"	10	174° - 48'	75.2'
"	"	8	175° - 11'	225.9'
"	"	C.P.1	316° - 38' - 30"	110.9'
C.P.1	11	T.P.A	46° - 51'	169.2'
"	"	12	106° - 52'	23.0'
"	"	13	188° - 43'	76.0'
"	"	14	205° - 16'	143.8'
"	"	15	207° - 59' - 30"	222.2'

UPD-X SURVEY DATA

MISSION NO. _____ SITUATION WINTER 1

EQUIPMENT ARMOR LOCATION VEE FORMATION

∧	BS	FS	ANGLE	DISTANCE ∧ TO FS
T.P.A	C.P.1	16	257° - 27' - 30"	149.9'
"	"	17	257° - 21'	223.3'
"	"	18	"	298.0'
18	T.P.A	19	87° - 23'	74.7'
"	"	20	87° - 15'	151.6'

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UPD-X SURVEY DATA

MISSION NO. _____ SITUATION 5A

EQUIPMENT CONVOY LOCATION HQ

∠	BS	FS	ANGLE	DISTANCE ∠ TO FS
1W10	10-A-10 SSM	15	63° - 30'	83.2'
"	"	16	80° - 22'	150.3'
"	"	17	90° - 38'	221.8'
"	"	13	352° - 25' - 30"	200.5'
"	"	14	352° - 28' - 30"	133.6'
17	1W10	18	208° - 51' - 30"	77.0'
17	"	19	208° - 40' - .30"	153.4'
19	17	20	164° - 39'	76.8'

Page ___

UPD-X SURVEY DATA

MISSION NO. _____ SITUATION 5A

EQUIPMENT ARMOR LOCATION NEAR MOUND

⍲	BS	FS	ANGLE	DISTANCE ⍲ TO FS
2W17	1W11	8	293° - 43'	120.0'
"	"	9	309° - 14'	198.2'
9	8	10	108° - 02'	125.4'
10	9	11	72° - 00'	88.2'
"	"	12	"	174.0'

Page ___

UPD-X SURVEY DATA

MISSION NO. _____ SITUATION 5A

EQUIPMENT CONVOY LOCATION CRANE ROAD

∠	BS	FS	ANGLE	DISTANCE ∠ TO FS
MON. 1DC'56	10-A-11 SPARE	2	43° - 59'	63.8'
2	MON.	1	139° - 57'	93.3'
"	"	3	252° - 51'	124.1'
"	"	4	" "	207.0'
4	2	5	170° - 41'	135.0'
"	"	6	" "	222.6'
"	"	7	" "	317.1'

APPENDIX B

Geodetic Coordinates or UPD-X Targets

UPD-X SITUATION STATIC ARRAY 1-C

MISSION # 77-03 0677-01-C DATE 17 JUNE 1977 PAGE 1 OF 2

POSITION NUMBER	TYPE OF EQUIPMENT AND I.D. NUMBER		LATITUDE	LONGITUDE	ORIENTATI
STATIC 1	SAM MISSILE (ONE)	#101	43°02'23.3725"	75°39'26.1421"	286°T
STATIC 2	SAM MISSILE (TWO)	#102	21.3736"	25.9715"	238°T
STATIC 3	SAM MISSILE (TWO)	#103	20.2357"	24.2489"	232°T
STATIC 4	GENERATOR	#104	21.3764"	18.3201"	257°T
STATIC 5	RADAR VAN	#105	22.3889"	22.3653"	258°T
STATIC 6	RADAR VAN	#106	22.1708"	22.7940"	7°T
STATIC 7	RADAR ANTENNA TRAILER	#107	22.4206"	23.2809"	353°T
STATIC 8	LOW BLOW RADAR	#108	16.3022"	26.2867"	269°T
STATIC 9	90MM AA GUN	#109	15.4451"	26.2008"	357°T
STATIC 10	40MM AA GUN	#110	14.1155"	27.0688"	238°T
STATIC 11	DUMMY AA GUN	#111	13.7527"	26.0027"	179°T
STATIC 12	40MM AA GUN	#112	14.2107"	25.0857"	113°T
STATIC 13	DUMMY TANK	#113	12.4548"	18.9888"	263°T
STATIC 14	1½ TON CARGO TRAILER	#114	07.8020"	22.4540"	273°T
STATIC 15	SNOW CAT	#115	43°01'55.0380"	75°39'17.0409"	108°T
STATIC 16	SNOW CAT	#116	55.0380"	15.0410"	259°T
STATIC 17	WATER TRAILER	#117	43.0000"	15.0000"	332°T

MISSION # 77-03 0677-01-C

UPD-X SITUATION STATIC ARRAY 1-C

DATE 17 JUNE 1977

POSITION NUMBER	TYPE OF EQUIPMENT AND I.D. NUMBER		LATITUDE	LONGITUDE	ORIENTATIO
STATIC 18	CRANE	#118	43°01'57.1836"	75°38'51.8968"	249°T
STATIC 19	FLATBED TRAILER	#119	43°02'00.0966"	75°38'52.6321"	168°T
STATIC 20	BOAT	#120	00.2868"	52.3011"	108°T
STATIC 21	JEEP	#211	43°01'57.9090"	46.6970"	222°T
STATIC 22	JEEP	#212	59.4400"	47.7940"	198°T
STATIC 23	JEEP	#210	59.4970"	49.1070"	178°T
STATIC 24	JEEP	#201	59.0650"	50.2820"	143°T
STATIC 25	JEEP	#202	58.2600"	51.0060"	114°T
STATIC 26	JEEP	#203	57.3620"	50.6510"	89°T
STATIC 27	JEEP	#215	57.6720"	48.5960"	293°T

UPD-X SITUATION 1-C

MISSION # 77-03 0677-01-C DATE 17 JUNE 1977 PAGE 1 OF 3

POSITION NUMBER	TYPE OF EQUIPMENT AND I.D. NUMBER		LATITUDE	LONGITUDE	ORIENTATIC
1	5 TON TRAILER	#311	43°02'21.8208"	75°39'24.5481"	83°T
2	2½ TON BOX BODY	#322	20.8903"	23.0480"	6°T
3	CIVILIAN 2½TON CARGO	#315	22.9781"	24.6223"	119°T
4	2½ TON CARGO	#323	24.2120"	23.1002"	100°T
5	2½ TON CARGO	#324	23.0956"	21.7248"	104°T
6	JEEP	#217	24.5919"	19.0928"	94°T
7	2½ TON BOX BODY	#312	23.6756"	20.0715"	2°T
8	2½ TON BOX BODY	#314	22.8395"	20.0301"	4°T
9	JEEP	#216	21.9542"	19.8682"	339°T
10	2½ TON BOX BODY	#313	21.9452"	21.6971"	78°T
11	JEEP	#204	03.1201"	75°38'57.2731"	181°T
12	2½ TON TANKER	#304	03.8609"	57.3019"	186°T
13	2½ TON BOX BODY	#310	04.6074"	57.3700"	184°T
14	2½ TON BOX BODY	#320	05.3485"	57.4284"	182°T
15	2½ TON TANKER	#316	06.0747"	58.6988"	155°T
16	2½ TON CARGO	#317	06.8006"	58.9708"	185°T
17	2½ TON BOX BODY	#318	07.5331"	58.9575"	179°T

UPD-X SITUATION 1-C

MISSION # 77-03 0677-01-C DATE 17 JUNE 1977 PAGE 2 OF 3

POSITION NUMBER	TYPE OF EQUIPMENT AND I.D. NUMBER		LATITUDE	LONGITUDE	ORIENTATIO
18	JEEP	#208	43°02'08.3035"	75°38'59.1145"	164°T
19	APC M-59	#606	04.5054"	58.6308"	310°T
20	TANK M-48	#601	04.4172"	59.6307"	313°T
21	SP GUN 8"	#608	04.3208"	75°39'00.6334"	315°T
22	SP GUN 8"	#609	04.2263"	01.6132"	302°T
23	TANK M-48	#602	04.1329"	02.6108"	301°T
24	TANK M-48	#603	03.4040"	02.4554"	289°T
25	SP GUN 8"	#610	02.6583"	02.2557"	310°T
26	SP GUN M-44	#604	01.9143"	02.1163"	292°T
27	APC M-84	#605	01.1913"	01.9444"	283°T
28	APC M-84	#607	03.4867"	01.4086	312°T
29	ARTILLERY 8"	#503	01.0012"	75°38'53.9460"	308°T
30	ARTILLERY 8"	#501	01.0809"	53.0088"	314°T
31	ARTILLERY 8"	#502	02.0773"	52.5653"	318°T
32	HOUND DOG MISSILE	#401	43°01'53.1849"	45.8958"	0°T
33	HOUND DOG MISSILE	#402	53.1585"	46.9049"	1°T
34	HONEST JOHN MISSILE	#403	53.1337"	47.9226"	3°T

MISSION # 77-03 0677-01-C

UPD-X SITUATION 1-C

DATE 17 JUNE 1977

POSITION NUMBER	TYPE OF EQUIPMENT AND I.D. NUMBER		LATITUDE	LONGITUDE	ORIENTATIO
35	JEEP	#214	43°01'43.1645"	75°39'08.7039"	177°T
36	2½ TON CARGO	#309	43.9209"	08.7285"	184°T
37	2½ TON CARGO	#308	44.6952"	08.7551"	184°T
38	2½ TON CARGO	#307	45.4367"	08.7771"	182°T
39	2½ TON CARGO	#306	46.2177"	08.8028"	182°T
40	JEEP	#213	46.9840"	08.8280"	178°T
41	JEEP	#209	43°02'07.4206"	10.1897"	335°T
42	JEEP	#205	06.7295"	09.7748"	332°T
43	2½ TON CARGO	#310	06.0860"	09.2535"	330°T
44	2½ TON CARGO	#301	05.4877"	08.6976"	328°T
45	2½ TON CARGO	#302	04.8478"	08.1055"	0°T
46	2½ TON CARGO	#303	04.0759"	07.9294"	355°T
47	2½ TON CARGO	#305	03.2543"	07.6941"	348°T
48	JEEP	#218	02.4925	07.4507"	8°T
49	JEEP	#219	01.7297"	07.7175"	22°T

UPD-X SITUATION 2-C

MISSION #77-04 0677-02-C DATE 30 JUNE 1977 PAGE 1 OF 3

POSITION NUMBER	TYPE OF EQUIPMENT AND I.D. NUMBER	LATITUDE	LONGITUDE	ORIENTATIOI
1	¼ TON JEEP	43°02'07.3191"	75°38'57.6959"	359°T
2	2½ TON TANKER	06.6617"	57.6051"	359°T
3	2½ TON BOX BODY	05.6907"	56.4100"	277°T
4	2½ TON BOX BODY	05.5485"	55.4233"	287°T
5	2½ TON TANKER (MIL.)	05.2520"	54.4449"	290°T
6	2½ TON CARGO (CIV.)	04.8562"	53.5597"	296°T
7	2½ TON BOX BODY	04.4676"	52.6780"	266°T
8	2½ TON CARGO	04.2606"	51.6832"	265°T
9	2½ TON CARGO	04.0759"	50.6773"	274°T
10	¼ TON JEEP	03.2375"	50.7366"	261°T
11	¼ TON JEEP	02.6032"	50.7815"	272°T
12	¼ TON JEEP	01.9976"	50.8294"	271°T
13	¼TON JEEP	01.3271"	50.8796"	275°T
14	¼ TON JEEP	02.5753"	49.7733"	241°T
15	¼ TON JEEP	01.9353"	49.7815"	232°T
16	¼ TON JEEP	01.3003"	49.7912"	240°T
17	¼ TON JEEP	43°01'52.1579"	45.5374"	259°T

UPD-X SITUATION 2-C

MISSION # 77-04 0677-02-C DATE 30 JUNE 1977 PAGE 2 OF 3

POSITION NUMBER	TYPE OF EQUIPMENT AND I.D. NUMBER	LATITUDE	LONGITUDE	ORIENTATIC
18	2½ TON CARGO	43°01'52.6957"	75°38'44.8467"	207°T
19	2½ TON BOX BODY	53.4489"	44.9286"	180°T
20	2½ TON BOX BODY	54.1972"	45.0101"	182°T
21	2½ TON BOX BODY	54.9346"	45.0903"	180°T
22	2½ TON BOX BODY	55.6445"	45.1676"	174°T
23	5 TON TANKER	56.3781"	45.2474"	184°T
24	2½ TON CARGO	57.1017"	45.3262"	186°T
25	2½ TON CARGO	57.8372"	45.4063"	178°T
26	¼ TON JEEP	58.6023"	45.4895"	177°T
27	HONEST JOHN MISSILE	54.9445"	48.5263"	316°T
28	HOUND DOG MISSILE	54.2076"	48.8372"	310°T
29	HOUND DOG MISSILE	53.8634"	50.0445"	304°T
30	APC M-59	43°02'08.9678"	59.9988"	303°T
31	TANK	08.0541"	75°39'01.1547"	300°T
32	SP GUN M-44	07.4655"	01.8993"	313°T
33	SP GUN 8"	06.8791"	02.6412"	318°T
34	SP GUN 8"	06.3035"	03.3693"	321°T

UPD-X SITUATION 2-C

MISSION #77-04 0677-02-C DATE 30 JUNE 1977 PAGE 3 OF 3

POSITION NUMBER	TYPE OF EQUIPMENT AND I.D. NUMBER	LATITUDE	LONGITUDE	ORIENTATION
35	TANK	43°02'05.7518"	75°39'04.0672"	316°T
36	SP GUN 8"	05.1437"	04.8366"	323°T
37	TANK	04.4487"	05.7158"	314°T
38	APC M-84	03.8376"	06.4888"	310°T
39	APC M-84	06.2860"	01.6823"	312°T
40	8" CANNON	43°01'47.3602"	75°38'57.1309"	352°T
41	8" CANNON	47.0041"	55.9260"	345°T
42	8" CANNON	47.3313"	54.8778"	348°T
43	2½ TON CARGO	45.8221"	44.5238"	310°T
44	2½ TON CARGO	45.1559"	44.4282"	306°T
45	2½ TON CARGO	44.5310"	44.3386"	308°T
46	2½ TON CARGO	43.8916"	44.2469"	320°T
47	2½ TON CARGO	45.7386"	45.5137"	48°T
48	2½ TON CARGO	45.0818"	45.5347"	50°T
49	2½ TON CARGO	44.4006"	45.5564"	60°T

UPD-X SITUATION 3-C

MISSION # 77-05 0777-03-C DATE 14 JULY 1977 PAGE 1 OF 3

POSITION NUMBER	TYPE OF EQUIPMENT AND I.D. NUMBER		LATITUDE	LONGITUDE	ORIENTATIC
1	2½ TON CARGO	#306	43°01'44.6031"	75°38'49.8452"	45°T
2	2½ TON CARGO	#307	43.9711"	51.1964"	64°T
3	2½ TON CARGO	#308	43.3392"	52.5504"	83°T
4	HONEST JOHN MISSILE	#403	45.2019"	50.5382"	323°T
5	¼ TON JEEP	#214	44.6439"	51.8043"	297°T
6	HOUND DOG MISSILE	#402	44.0936"	53.0530"	316°T
7	HOUND DOG MISSILE	#401	43.5865"	54.2037"	313°T
8	2½ TON CARGO	#305	44.5063"	54.7694"	294°T
9	2½ TON CARGO	#309	44.9940"	53.6503"	299°T
10	2½ TON CARGO	#303	45.4716"	52.5543"	286°T
11	2½ TON CARGO	#302	45.9674"	51.4166"	305°T
12	¼ TON JEEP	#218	50.4639"	45.4061"	14°T
13	¼ TON JEEP	#208	50.5682"	46.6623"	6°T
14	¼ TON JEEP	#217	51.3991"	47.4699"	84°T
15	¼ TON JEEP	#216	52.0287"	47.1641"	165°T
16	¼ TON JEEP	#209	56.1075"	47.8300"	94°T
17	2½ TON BOX BODY	#320	56.1481"	49.0797"	94°T

UPD-X SITUATION 3-C

MISSION # 77-05 0777-03-C DATE 14 JULY 1977 PAGE 2 OF 3

POSITION NUMBER	TYPE OF EQUIPMENT AND I.D. NUMBER		LATITUDE	LONGITUDE	ORIENTATIO
18	2½ TON TANKER	#316	43°01'56.1893"	75°38'50.3506"	94°T
19	2½ TON CARGO	#317	56.2275"	51.5288"	92°T
20	2½ TON BOX BODY	#318	56.2864"	53.3447"	102°T
21	2½ TON CARGO	#310	56.4546"	54.4371"	103°T
22	2½ TON CARGO	#301	56.7063"	56.0725"	159°T
23	2½ TON BOX BODY	#319	57.6108"	53.3133"	169°T
24	2½ TON TANKER	#304	58.5656"	56.5675"	168°T
25	¼ TON JEEP	#219	59.4876"	56.8130"	168°T
26	APC	#607	43°02'00.9449"	75°39'00.0366"	293°T
27	TANK	#602	00.8573"	75°38'58.6833"	309°T
28	8" SP GUN	#610	01.7355"	59.3460"	307°T
29	8" SP GUN	#609	03.7917"	56.2221"	328°T
30	TANK	#603	04.6083"	56.2459"	324°T
31	APC	#605	04.1888"	55.1594"	332°T
32	8" SP GUN	#608	07.1793"	54.6588"	335°T
33	APC	#606	06.0827"	54.0747"	321°T
34	SP GUN	#604	06.5605"	53.0850"	320°T

UPD-X SITUATION 3-C

MISSION # 77-05 0777-03-C DATE 14 JULY 1977 PAGE 3 OF 3

POSITION NUMBER	TYPE OF EQUIPMENT AND I.D. NUMBER		LATITUDE	LONGITUDE	ORIENTATIC
35	TANK	#601	43°02'07.6218"	75°38'53.6298"	324°T
36	8" ARTILLERY	#503	43°01'45.7647"	75°39'02.8493"	0°T
37	8" ARTILLERY	#501	45.7011"	04.1335"	357°T
38	8" ARTILLERY	#502	45.6412"	05.3410"	357°T
39	¼ TON JEEP	#213	43°02'13.1537"	23.5370"	194°T
40	2½ TON CARGO	#324	14.2536"	23.6176"	194°T
41	2½ TON CARGO	#323	15.3188"	23.6956"	182°T
42	5 TON TANKER	#311	16.3822"	23.7735"	202°T
43	2½ TON BOX BODY	#314	17.9912"	21.8147"	239°T
44	2½ TON CARGO	#315	19.0020"	20.5842"	240°T
45	2½ TON BOX BODY	#312	19.8218"	19.5860"	282°T
46	2½ TON BOX BODY	#322	19.8377"	17.2673"	273°T
47	2½ TON BOX BODY	#313	19.8474"	15.8334"	276°T
48	¼ TON JEEP	#204	20.7998"	15.0068"	192°T
49	¼ TON JEEP	#205	22.9470"	16.1100"	85°T

UPD-X SITUATION 4A

MISSION # 78-07 0378-04-A DATE MARCH 21, 1978 PAGE 1 OF 2

POSITION NUMBER	TYPE OF EQUIPMENT AND I.D. NUMBER		LATITUDE	LONGITUDE	ORIENTATIO
1	¼ TON JEEP	#214	43°01'43.1645"	75°39'08.7039"	346°T
2	2½ TON CARGO TRUCK	#310	43.9209"	08.7285"	340°T
3	2½ TON CARGO TRUCK	#308	44.6952"	08.7551"	337°T
4	2½ TON CARGO TRUCK	#305	45.4367"	08.7771"	340°T
5	2½ TON CARGO TRUCK	#309	46.2177"	08.8028"	339°T
6	2½ TON CARGO TRUCK	#301	46.9840"	08.8280"	346°T
7	¼ TON JEEP	#217	47.8036"	08.8550"	338°T
8	¼ TON JEEP	#204	43°02'03.1201"	75°38'57.2731"	161°T
9	¼ TON JEEP	#208	03.8609"	57.3019"	158°T
10	2½ TON TANKER	#316	04.6074"	57.3700"	158°T
11	2½ TON BOX BODY TRUCK	#318	05.3485"	57.4284"	157°T
12	2½ TON CARGO TRUCK CIV.	#317	06.0747"	58.6988"	135°T
13	2½ TON BOX BODY TRUCK	#313	06.8006"	58.9708"	162°T
14	2½ TON CARGO TRUCK	#324	07.5331"	58.9575"	152°T
15	¼ TON JEEP	#205	08.3035"	59.1145"	132°T
16	APC	#607	04.3208"	75°39'00.6334"	307°T
17	M-48 TANK	#601	04.2263"	01.6132"	295°T

UPD-X SITUATION 4A

MISSION # 78-07 0378-04-A DATE MARCH 21, 1978 PAGE 2 OF 2

POSITION NUMBER	TYPE OF EQUIPMENT AND I.D. NUMBER		LATITUDE	LONGITUDE	ORIENTATIO
18	APC	#605	43°02'04.1329"	75°39'02.6108"	297°T
19	8" SP GUN	#610	03.4040"	02.4554"	300°T
20	SP GUN M-44	#604	02.6583"	02.2557"	301°T

UPD-X SITUATION 5-A

MISSION # 78-08 / 0478-05-A DATE 4 APRIL 1978 PAGE 1 OF 2

POSITION NUMBER	TYPE OF EQUIPMENT AND I.D. NUMBER		LATITUDE	LONGITUDE	ORIENTATIC
1	¼ TON JEEP	#220	43°02'57.6108"	75°39'53.3133"	163° T.
2	2½ TON CARGO TRUCK	310	56.7063"	56.0725"	151
3	2½ TON CARGO TRUCK	308	56.4546"	54.4371"	74
4	2½ TON CARGO TRUCK	305	56.2864"	53.3447"	71
5	2½ TON CARGO TRUCK	309	43°01'56.2275"	75°38'51.5288"	56
6	2½ TON CARGO TRUCK	301	56.1893"	50.3506"	58
7	¼ TON JEEP	214	56.1481"	49.0797"	75
8	TANK (M-48)	601	43°02'04.1888"	55.1594"	298
9	S.P. GUN (M-55)	610	03.7917"	56.2221"	299
10	APC	607	02.5682"	55.9592"	290
11	APC	605	02.9631"	54.9007"	308
12	S.P. GUN (M-44)	604	03.3473"	53.8701"	293
13	¼ TON JEEP	208	07.3191"	57.6959"	162
14	2½ TON BOX BODY TRUCK	318	06.6617"	57.6051"	158
15	2½ TON TANKER	316	05.6970"	56.4100"	88
16	2½ TON CARGO TRUCK	324	05.5485"	55.4233"	80
17	2½ TON BOX BODY TRUCK	313	05.2520"	54.4449"	92

UPD-X SITUATION 5-A

MISSION # 78-08 / 0478-05-A DATE 4 APRIL 1978 PAGE 2 OF 2

POSITION NUMBER	TYPE OF EQUIPMENT AND I.D. NUMBER		LATITUDE	LONGITUDE	ORIENTATIC
18	2½ TON CARGO TRUCK	#317	43°02'04.8562"	75°38'53.5597"	93° T.
19	¼ TON JEEP	204	04.4676"	52.6780"	91
20	¼ TON JEEP	205	04.2606"	51.6832"	88

UPD-X SITUATION WINTER STATIC ARRAY

MISSION # 78-08 / 0478-05-A DATE 4 APRIL 1978 PAGE 1 OF 4

POSITION NUMBER	TYPE OF EQUIPMENT AND I.D. NUMBER		LATITUDE	LONGITUDE	ORIENTA
STATIC 1	SAM MISSILE (ONE)	#101	43°02'23.3725"	75°39'26.1421"	286°T
STATIC 2	SAM MISSILE (TWO)	#102	21.3736"	25.9715"	238°T
STATIC 3	SAM MISSILE (TWO)	#103	20.2357"	24.2489"	232°T
STATIC 4	GENERATOR	#104	21.3764"	18.3201"	257°T
STATIC 5	RADAR VAN	#105	22.3889"	22.3653"	258°T
STATIC 6	RADAR VAN	#106	22.1708"	22.7940"	7°T
STATIC 7	RADAR ANTENNA TRAILER	#107	22.4206"	23.2809"	353°T
STATIC 8	LOW BLOW RADAR	#108	16.3022"	26.2867"	269°T
STATIC 9	90MM AA GUN	#109	15.4451"	26.2008"	357°T
STATIC 10	40MM AA GUN	#110	14.1155"	27.0688"	238°T
STATIC 11	DUMMY AA GUN	#111	13.7527"	26.0027"	179°T
STATIC 12	40MM AA GUN	#112	14.2107"	25.0857"	113°T
STATIC 13	DUMMY TANK	#113	12.4548"	18.9888"	263°T
STATIC 14	1½ TON CARGO TRAILER	#114	07.8020"	22.4540"	273°T
STATIC 15	SNOW CAT	#115	43°01'55.0380"	75°39'17.0409"	108°T
STATIC 16	SNOW CAT	#116	55.0380"	15.0410"	259°T
STATIC 17	WATER TRAILER	#117	43.0000"	15.0000"	332°T

MISSION # 78-08
0478-05-A

OPD-X SITUATION WINTER STATIC ARRAY

DATE 4 APRIL 1978

POSITION NUMBER	TYPE OF EQUIPMENT AND I.D. NUMBER		LATITUDE	LONGITUDE	ORIENTA
STATIC 18	CRANE	#118	43°01'57.1836"	75°38'51.8968"	249°T
STATIC 19	FLATBED TRAILER	#119	43°02'00.0966"	75°38'52.6321"	168°T
STATIC 20	BOAT	#120	00.2868"	52.3011"	108°T
STATIC 21	JEEP	#211	43°01'57.9090"	46.6970"	222°T
STATIC 22	JEEP	#212	59.4400"	47.7940"	198°T
STATIC 23	JEEP	#210	59.4970"	49.1070"	178°T
STATIC 24	JEEP	#201	59.0650"	50.2820"	143°T
STATIC 25	JEEP	#202	58.2600"	51.0060"	114°T
STATIC 26	JEEP	#203	57.3620"	50.6510"	89°T
STATIC 27	JEEP	#215	57.6720"	48.5960"	293°T
STATIC a	HONEST JOHN MISSILE	#403	54.9445"	48.5263"	301°T
STATIC b	HOUND DOG MISSILE	#401	54.2076"	48.8372"	299°T
STATIC c	HOUND DOG MISSILE	#402	53.8634"	50.0445"	295°T
STATIC d	8" CANNON	#503	47.3313"	54.8778"	338°T
STATIC e	8" CANNON	#501	47.0041"	55.9260"	340°T
STATIC f	8" CANNON	#502	47.3602"	57.1309"	339°T
STATIC g	TANK M-48	#603	43°02'08.0541"	75°39'01.1547"	304°T

UPD-X SITUATION WINTER STATIC ARRAY

MISSION # 78-08
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DATE 4 APRIL 1978

POSITION NUMBER	TYPE OF EQUIPMENT AND I.D. NUMBER		LATITUDE	LONGITUDE	ORIENTATI(
TATIC h	TANK	#602	43°02'07.4655"	75°39'01.8993"	298°T
TATIC i	8" SP GUN	#608	06.8791"	02.6412"	318°T
TATIC j	APC	#606	06.3035"	03.3693"	301°T
TATIC k	8" SP GUN	#609	05.7518"	04.0672"	317°T
TATIC l	¼ TON JEEP	#209	07.4206"	10.1897"	312°T
TATIC m	2½ TON CARGO TRUCK	#323	06.7295"	09.7748"	321°T
TATIC n	2½ TON BOX BODY	#320	06.0860"	09.2535"	310°T
TATIC o	2½ TON CARGO	#319	05.4877"	08.6976"	306°T
TATIC p	2½ TON CARGO	#307	04.8478"	08.1055"	331°T
TATIC q	2½ TON TANKER	#304	04.0759"	07.9294"	329°T
TATIC r	¼ TON JEEP	#216	03.2543"	07.6941"	323°T
TATIC s	¼ TON JEEP	#218	02.4925"	07.4507"	352°T
TATIC t	¼ TON JEEP	#219	24.5919"	19.0928"	68°T
TATIC u	2½ TON BOX BODY	#312	23.6756"	20.0715"	335°T
TATIC v	2½ TON BOX BODY	#314	22.8395"	20.0301"	334°T
TATIC w	¼ TON TANKER	#206	21.9542"	19.8682"	317°T
TATIC x	2½ TON TANKER	#302	23.0956"	21.7248"	85°T

UPD-X SITUATION WINTER STATIC ARRAY

MISSION # 78-08
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DATE 4 APRIL 1978

PAGE 4 OF 4

POSITION NUMBER	TYPE OF EQUIPMENT AND I.D. NUMBER		LATITUDE	LONGITUDE	ORIENTATI(
STATIC y	5 TON TANKER	#311	43°02'21.9452"	75°39'21.6971"	49°T
STATIC z	2½ TON BOX BODY	#306	20.8903"	23.0480"	342°T
STATIC aa	2½ TON BOX BODY	#322	24.2120"	23.1002"	85°T
STATIC bb	2½ TON TRUCK CIV.	#315	22.9781"	24.6223"	98°T
STATIC cc	2½ TON TRUCK	#303	21.8208"	24.5481"	57°T

UPD-X SITUATION UPD-X WINTER TEST ICA-1

MISSION # 78-07 0378-04-A DATE MARCH 21, 1978 PAGE 1 OF 1

POSITION NUMBER	TYPE OF EQUIPMENT AND I.D. NUMBER	LATITUDE	LONGITUDE	ORIENTATIO
REFERENCE STAKE		43°02'04.8337"	75°39'23.0904"	
A	1000ft²/100m² REFLECTORS	04.4454"	24.0119"	0°T
B	"	04.7451"	22.6436"	"
C	"	03.7413"	22.2351"	"
D	"	03.4416"	23.6034"	"
E	"	04.0934"	23.1235"	"

UPD-X SITUATION UPD-X WINTER TEST ICA-2

MISSION # 78-07 0378-04-A DATE MARCH 21, 1978 PAGE __ OF __

POSITION NUMBER	TYPE OF EQUIPMENT AND I.D. NUMBER	LATITUDE	LONGITUDE	ORIENTATIC
REFERENCE STAKE		43°02'10.7063"	75°39'05.8380"	
A	1000ft²/100m² REFLECTORS	10.3077"	06.7514"	0°T
B	"	10.6227"	05.3893"	"
C	"	09.6235"	04.9600"	"
D	"	09.3085"	06.3220"	"
E	"	09.9656"	05.8558"	"

UPD-X SITUATION UPD-X WINTER TEST ICA-3

MISSION # 78-07 0378-04-A DATE MARCH 21, 1978 PAGE 1 OF 1

POSITION NUMBER	TYPE OF EQUIPMENT AND I.D. NUMBER	LATITUDE	LONGITUDE	ORIENTATION
REFERENCE STAKE		43°01'.45.8108"	75°38'57.2079"	
A	1000ft²/100m² REFLECTORS	45.4079"	58.1177"	0°T
B	"	45.7293"	56.7586"	"
C	"	44.7322"	56.3205"	"
D	"	44.4108"	57.6795"	"
E	"	45.0700	57.2191"	"

UPD-X SITUATION UPD-X WINTER TEST ICA-4

MISSION # 78-07 G378-04-A DATE MARCH 21, 1978 PAGE 1 OF 1

POSITION NUMBER	TYPE OF EQUIPMENT AND I.D. NUMBER	LATITUDE	LONGITUDE	ORIENTATIO
REFERENCE STAKE		43°01'46.4412"	75°39'04.0889"	
A	1000ft²/100m² REFLECTORS	46.0606"	05.0163"	0°T
B	"	46.3488"	03.6435"	"
C	"	45.3415"	03.2507"	"
D	"	45.0534"	04.6336"	"
E	"	45.7011"	04.1335"	"

UPD-X SITUATION UPD-X WINTER TEST ICA-5

MISSION # 78-07 0378-04-A DATE MARCH 21, 1978 PAGE 1 OF 1

POSITION NUMBER	TYPE OF EQUIPMENT AND I.D. NUMBER	LATITUDE	LONGITUDE	ORIENTATI(
REFERENCE STAKE		43°01'47.9144"	75°39'16.4560"	
A	1000ft²/100m² REFLECTORS	47.6578"	17.4595"	0°T
B	"	47.7666"	16.0392"	"
C	"	46.7246"	15.8910"	"
D	"	46.6159"	17.3112"	"
E	"	47.1912"	16.6752"	"

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